532 Rec'd PCT/PTC 04 AUG 2000

FORM PCT 1390 REV. 5/93 — U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NO
BIERBAUMER ET AL. - 2

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)
09/601588

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/AT99/00027	FEBRUARY 2, 1999	FEBRUARY 5, 1998

TITLE OF INVENTION
METHOD FOR IRRADIATING AN ITEM

APPLICANT(S) FOR DO/EO/US
HANS-PETER BIERBAUMER ET AL.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. X This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ___ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. X This is an express request to begin national examination procedures (35 U.S.C. 371 (f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(l).
4. X A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. X A copy of the International Application as filed (35 U.S.C. 371(c)(2)
   a. X is transmitted herewith (required only if not transmitted by the International Bureau)
   b. ___ has been transmitted by the International Bureau.
   c. ___ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. X A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ___ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   a. ___ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ___ have been transmitted by the International Bureau.
   c. ___ have not been made; however, the time limit for making such amendments has **NOT** expired.
   d. ___ have not been made and will not be made.
8. ___ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ___ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ___ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. X An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ___ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. X A **FIRST** preliminary amendment.
    ___ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ___ A substitute specification.
15. ___ A change of power of attorney and/or address letter.
16. X Other items or information:

    PCT/ISA/210 - Int'l. Search Report (English)
    10 Sheets of Formal Drawings

532 Rec'd PCT/PTO 04 AUG 2000

APPLICATION NO. (if known, see 37 CFR 1.5) 09/601588	INTERNATIONAL APPLICATION NO. PCT/AT99/00027	ATTORNEY'S DOCKET NO. BIERBAUMER-2
_X_ The following fees are submitted: **Basic National Fee (37 CFR 1.492(a)(1)-(5)):** Search Report has been prepared by the EPO or JPO........................**$840.00**	CALCULATIONS	PTO USE ONLY
International preliminary examination fee paid to USPTO (37 CFR 1.482) **$670.00**		
Neither international preliminary examination fee paid (37 CFR 1.82) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO.........**$970.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4)..................$96 **ENTER APPROPRIATE BASIC FEE AMOUNT =**	$ 840.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ___ 20 ___ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).		

Claims	Number Filed	Number Extra	Rate		
Total Claims	102 - 20 =	- 82 -	X **$18.00**	$ 1,476.00	
Independent Claims	2 - 3 =	- 0 -	X **$78.00**	$	
Multiple dependent claim(s) (if applicable)			+ **$260.00**	$	
TOTAL OF ABOVE CALCULATIONS =				$ 2,316.00	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$ 2,316.00	
Processing fee of **$130.00** for furnishing the English translation later than ___ 20 ___ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 2,316.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +					
TOTAL FEES ENCLOSED =				$ 2,316.00	
				Amount to be: refunded	$
				charged	$

a. _X_ A check in the amount of $2,316.00 to cover the above fees is enclosed.

b. ___ Please charge my Deposit Account No. 03-2468 in the amount of $________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. _X_ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment, to Deposit Account No. 03-2468. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
COLLARD & ROE, P.C.
1077 Northern Boulevard
Roslyn, New York 11576-1696
(516) 365-9802

Edward R. Freedman

Signature

Edward R. Freedman
Reg. No. 26,048

Express Mail No. EL621967440US
Date of Deposit August 4, 2000

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10, on the date indicated above, and is addressed to the Ass't. Commissioner for Patents, Washington, D.C. 20231

Edward R. Freedman

Edward R. Freedman

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANTS: HANS-PETER BIERBAUMER ET AL-2

PCT NO.: PCT/AT99/00027

FILED: 2 FEBRUARY 1999

TITLE: METHOD FOR IRRADIATING AN ITEM

PRELIMINARY AMENDMENT

BOX PCT
Ass't. Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Preliminary to the initial Office Action, please amend the above-identified application as follows:

IN THE CLAIMS:

Please cancel claims 1 and 9 and replace them with new claim 104 and amend the claims as follows:

--104. A method of irradiating an object, in particular a material, an item of waste, a component, a foodstuff, a liquid, a gas or similar, whereby the object is displaced by means of a conveyor system through a beam of particles emitted from at least one radiation device, in particular an electron accelerator, in an irradiating chamber, whereby the electrons from an

incandescent cathode needed for irradiation purposes are focussed and pulsed in an accelerator unit with waves of a specific, pre-definable frequency and are emitted from the electron-emitting device at a specific frequency and directed onto the object to be irradiated, characterised in that the object is irradiated on a process conveyor describing a vertical motion through the electron beam.--

Claim 2, line 1, delete "claim 1" and insert --claim 104--.

Claim 3, line 1, delete "claim 1 or 2" and insert --claim 104--.

Claim 4, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 5, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 6, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 7, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 8, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 10, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 11, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 12, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 13, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 14, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 15, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 16, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 17, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 18, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 19, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 20, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 21, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 22, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 23, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 24, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 25, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 26, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 27, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 28, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 29, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 30, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 31, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 32, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 33, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 34, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 35, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 36, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 37, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 38, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 39, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 40, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 41, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 42, line 1, delete "one or more of the preceding claims" and insert --claim 104--.

Claim 45, line 1, delete "or 44".

Claim 46, line 1, delete "one or more of claims 43 to 45" and insert --claim 43--.

Claim 47, line 1, delete "one or more of claims 43 to 46" and insert --claim 43--.

Claim 48, line 1, delete "one or more of claims 43 to 47" and insert --claim 43--.

Claim 49, line 1, delete "one or more of claims 43 to 48" and insert --claim 43--.

Claim 50, line 1, delete "one or more of claims 43 to 49" and insert --claim 43--.

Claim 51, line 1, delete "one or more of claims 43 to 50" and insert --claim 43--.

Claim 52, line 1, delete "one or more of claims 43 to 51" and insert --claim 43--.

Claim 53, line 1, delete "one or more of claims 43 to 52" and insert --claim 43--.

Claim 54, line 1, delete "one or more of claims 43 to 53" and insert --claim 43--.

Claim 55, line 1, delete "one or more of claims 43 to 54" and insert --claim 43--.

Claim 56, line 1, delete "one or more of claims 43 to 55" and insert --claim 43--.

Claim 57, line 1, delete "one or more of claims 43 to 56" and insert --claim 43--.

Claim 58, line 1, delete "one or more of claims 43 to 57" and insert --claim 43--.

Claim 59, line 1, delete "one or more of claims 43 to 58" and insert --claim 43--.

Claim 60, line 1, delete "one or more of claims 43 to 59" and insert --claim 43--.

Claim 61, line 1, delete "one or more of claims 43 to 60" and insert --claim 43--.

Claim 62, line 1, delete "one or more of claims 43 to 61" and insert --claim 43--.

Claim 63, line 1, delete "one or more of claims 43 to 62" and insert --claim 43--.

Claim 64, line 1, delete "one or more of claims 43 to 63" and insert --claim 43--.

Claim 65, line 1, delete "one or more of claims 43 to 64" and insert --claim 43--.

Claim 66, line 1, delete "one or more of claims 43 to 65" and insert --claim 43--.

Claim 67, line 1, delete "one or more of claims 43 to 66" and insert --claim 43--.

Claim 68, line 1, delete "one or more of claims 43 to 67" and insert --claim 43--.

Claim 69, line 1, delete "one or more of claims 43 to 68" and insert --claim 43--.

Claim 70, line 1, delete "one or more of claims 43 to 69" and insert --claim 43--.

Claim 71, line 1, delete "one or more of claims 43 to 70" and insert --claim 43--.

Claim 72, line 1, delete "one or more of claims 43 to 71" and insert --claim 43--.

Claim 73, line 1, delete "one or more of claims 43 to 72" and insert --claim 43--.

Claim 74, line 1, delete "one or more of claims 43 to 73" and insert --claim 43--.

Claim 75, line 1, delete "one or more of claims 43 to 74" and insert --claim 43--.

Claim 76, line 1, delete "one or more of claims 43 to 75" and insert --claim 43--.

Claim 77, line 1, delete "one or more of claims 43 to 76" and insert --claim 43--.

Claim 78, line 1, delete "one or more of claims 43 to 77" and insert --claim 43--.

Claim 79, line 1, delete "one or more of claims 43 to 78" and insert --claim 43--.

Claim 80, line 1, delete "one or more of claims 43 to 79" and insert --claim 43--.

Claim 81, line 1, delete "one or more of claims 43 to 80" and insert --claim 43--.

Claim 82, line 1, delete "one or more of claims 43 to 81" and insert --claim 43--.

Claim 83, line 1, delete "one or more of claims 43 to 82" and insert --claim 43--.

Claim 84, line 1, delete "one or more of claims 43 to 83" and insert --claim 43--.

Claim 85, line 1, delete "one or more of claims 43 to 84" and insert --claim 43--.

Claim 86, line 1, delete "one or more of claims 43 to 85" and insert --claim 43--.

Claim 87, line 1, delete "one or more of claims 43 to 86" and insert --claim 43--.

Claim 88, line 1, delete "one or more of claims 43 to 87" and insert --claim 43--.

Claim 89, line 1, delete "one or more of claims 43 to 88" and insert --claim 43--.

Claim 90, line 1, delete "one or more of claims 43 to 89" and insert --claim 43--.

Claim 91, line 1, delete "one or more of claims 43 to 90" and insert --claim 43--.

Claim 92, line 1, delete "one or more of claims 43 to 91" and insert --claim 43--.

Claim 93, line 1, delete "one or more of claims 43 to 92" and insert --claim 43--.

Claim 94, line 1, delete "one or more of claims 43 to 93" and insert --claim 43--.

Claim 95, line 1, delete "one or more of claims 43 to 94" and insert --claim 43--.

Claim 96, line 1, delete "one or more of claims 43 to 95" and insert --claim 43--.

Claim 97, line 1, delete "one or more of claims 43 to 96" and insert --claim 43--.

Claim 98, line 1, delete "one or more of claims 43 to 97" and insert --claim 43--.

Claim 99, line 1, delete "one or more of claims 43 to 98" and insert --claim 43--.

Claim 100, line 1, delete "one or more of claims 43 to 99" and insert --claim 43--.

Claim 101, line 1, delete "one or more of claims 43 to 100" and insert --claim 43--.

Claim 102, line 1, delete "one or more of claims 43 to 101" and insert --claim 43--.

Claim 103, line 1, delete "one or more of claims 43 to 102" and insert --claim 43--.

REMARKS

By this Preliminary Amendment, the application has been amended to conform with U.S. practice and the multiple dependency of certain claims has been removed so as to avoid the surcharge associated therewith. These changes correspond to changes made in the International application. No new matter has been introduced. Entry of this amendment is respectfully requested.

Respectfully submitted,
HANS-PETER BIERBAUMER ET AL

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Date of Deposit August 4, 2000

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. 1.10, on the date indicated above, and is addressed to the Ass't. Commissioner for Patents, Washington, D.C. 20231

Edward R. Freedman

Method for irradiating an item

The invention relates to a method for irradiating an item as defined by the characterising features of claim 1, and a system for irradiating an item as defined in claim 43.

Processing products of the most varied of species by chemical irradiation using radiation from the most varied of sources, e.g. γ or electron radiation, has become increasingly commonplace in recent years. By using high-energy radiation, this method can also be used as a means of sterilising produce. However, in addition to flushing with toxins such as methyl bromide or ethylene oxide, irradiation to date has involved the use of radioactive isotopes such as cobalt 60 or caesium 137 primarily as a means of achieving an increase in quality. Although methods of this type are effective in killing microbes, bacteria and germs to a high degree, it must always be borne in mind that the beam source is constantly activated and can not be "simply" switched off, so that the maintenance inspections inherent in these systems present a constant potential risk to maintenance personnel. Furthermore, irradiation techniques of this type are not without controversy, at least in the media world, making it very difficult to market produce treated in this way. Moreover, essential vitamins, minerals and nutrients are lost. An irradiation system of this type is known from US 3,564,241 A, for example. This document discloses a system in which produce of all types is loaded in baskets mounted on overhead rails, in readiness for sterilisation. The baskets are fed on these rails into the interior of a radiation chamber, where they are irradiated from both the front and the rear with cobalt 60, depending on the selected layout of the guide rails.

In order to avoid the above problems, the irradiation method was improved so that heated cathodes were used as the beam source instead of radioactive material. The electrons emitted from the cathode are accelerated towards the anode and focussed, before being finally deflected on to the products to be sterilised. Practice has shown that the products can be sterilised to a degree comparable with that achieved using a radioactive irradiation process. A system of this type is known from WO 94/22162 A. Apart from the nature of the beam source, this system is comparable with that disclosed in the above-mentioned US-A system in terms of structure. Here too, the produce is loaded into baskets guided on a rail and conveyed through the processing chamber. The disadvantage of using this system to convey the products is that, due to the selected conveyor system, specific parts of the conveyor baskets which are repeatedly subjected to constant

irradiation have a higher tendency to wear.
The underlying objective of the present invention is to propose a method and a system for irradiating an object, which enables electrons to be applied uniformly across as large a volume as possible.

This objective is achieved by the invention due to the characterising features of claim 1. The first advantage of using this type of method is that produce of the most varied of types, for example foodstuffs such as spices, water or similar, substances such as plastics, ceramics, metals or similar, can be irradiated in such a way that a significant improvement in quality is obtained. Another advantage is the fact that the electron radiation can be pulsed at a pre-definable frequency, which assists in distributing the dose uniformly in the object to be irradiated.

Another advantageous embodiment is defined in claim 2, enabling high-energy electrons to be accelerated in a simple manner.

The embodiment defined in claim 3 provides a capacity in which the electromagnetic waves generated can be propagated in the form of a stationary wave.

Claims 4 and 5 outline advantageous embodiments whereby a simple and safe operating technology can be used to accelerate the electrons on the one hand and amplify the effect of acceleration on the other.

Claim 6 defines an advantageous embodiment designed to further enhance the uniformity of the dose distributed in the object to be irradiated.

Also of advantage is an embodiment defined in claim 7, since it provides electrons with an energy which further enhances safety whilst producing the desired effect in the object to be irradiated.

The embodiment defined in claim 8 advantageously allows the required radiation dose to be adapted to the object to be irradiated, specifically on the basis of its dimensions.

Other embodiments defined in claims 9 and 10 are advantageous since they provide simple

means which enable the objects to be irradiated to be put through a multiple irradiation process.

An embodiment defined in claim 11 is of advantage because an accelerator unit can be provided, the output of which is sufficient to achieve the desired effects when irradiating the object or objects.

An irradiation system as defined in claims 12 and 13 has an advantage in that irradiation of the objects does not have any adverse effects on the parts of the system used to irradiate the objects.

A method as proposed in claim 14 is of advantage because when the objets are being moved downwards and upwards during multiple irradiation, the operating parameters of the system proposed by the invention can be kept at a level which allows fault-free operation for a long period.

Claim 15 defines another embodiment which advantageously shortens the irradiation process, thereby enabling a higher throughput of the objects.

Due to the embodiment outlined in claims 16 and/or 17, it is advantageously possible to adapt the dose administered to suit the respective properties of the objects to be irradiated at a high production rate.

With the variant of the method defined in claim 18, the dose administered during irradiation can be radio-chromatically stored for subsequent evaluation and this data can be accessed later for control purposes.

The embodiments defined in claims 19 and 20 enable the irradiation process to be automated to a high degree.

Also of advantage is the embodiment outlined in claim 21 since it provides an additional control and monitoring routine.

The advantage of the embodiment defined in claim 22 is that the method can be universally applied to objects of the most varied nature.

In accordance with an embodiment outlined in claims 23 and 24, simple means enable the objects to be irradiated and the conveyor elements used to be processed individually so that the irradiation process can be completed in a simple manner at a later stage.

The advantage of the embodiment defined in claim 25 is that a dosimeter used to control the radiation dose administered can be specifically assigned to the object to which the dosimeter was attached, thereby ensuring a high degree of safety.

Productivity can be increased by means of the advantageous embodiments outlined in claims 26 and 27.

The embodiment described in claim 28 advantageously improves the capacity utilisation of the accelerator unit.

Claim 29 defines an embodiment whereby it is advantageously possible to feed objects into the accelerator chamber depending on the degree of processing required.

The embodiment outlined in claim 30 has an advantage because it increases the degree of automation in the production process still further.

Another embodiment described in claim 31 allows the object to be irradiated several times, which means that the operating parameters of the accelerator unit can be retained at a high level, enabling it to be run without interruption for a long period.

The embodiment defined in claim 32 provides simple means of monitoring the objects as they are fed in and out.

The embodiment defined in claim 33 provides a simple means of allowing the irradiation process to be integrated in the production line of a manufacturing process for objects.

With the embodiment outlined in claim 34, when the objects have been irradiated, they can be fed away to a despatch area.

The embodiment outlined in claim 35 provides an effective means of defining the dose administered to the object.
The advantage of the embodiment described in claim 36 is that the minimum radiation dose to be applied can be directed across significant points in or on the object so that the parameters used in the production process itself can be selected to ensure that the object is best prepared for the irradiation process.

Also of advantage is an embodiment defined in claim 37, whereby the process parameters can be set, regulated and controlled depending on the radiation dose to be administered.

Claim 38 defines an advantageous embodiment whereby a means is provided which allows a repeated check to be made on the stability of the radiation process.

With the embodiment outlined in claim 39, the stability of the radiation process can be controlled individually and randomly.

The embodiment of the method described in claim 40 is of practical advantage because the radiation process can be checked at a glance by means of a display on a screen, for example.

The advantage of the embodiments described in claims 41 and 42 is that the individual system components, in particular the process conveyor and the electron accelerator system, can be regulated with a short time delay.

The task set by the invention is also solved by the features set out in claim 43. These offer advantages because the limit on the specific maximum size of the object is considerably higher than is the case with conventional systems and it is also possible to arrange the electron accelerator and the greater part of the conveyor system in different rooms. Accordingly, parts of the conveyor system are afforded the best possible protection against high exposure to radiation.

The embodiments outlined in claims 44 and 45 offer an advantage because the objet can be irradiated across the greater part of its surface.

By setting up the accelerator unit as defined in claims 46 or 47, the capital outlay for a system of

this type can advantageously be reduced since the room in which the electron accelerator is disposed can be kept to small dimensions and if arranged underground, in particular, the surrounding earth can be used as a screen against electron radiation.

The advantage of another embodiment defined in claim 48 is that special precautions usually needed for the infeed and outfeed, such as gating systems, can be dispensed with.

Claim 49 offers a cost-effective variant of a system as proposed by the invention.

By using the embodiment defined in claim 50, a system of the type proposed by the invention can be readily integrated in an overall plant for a production process. Furthermore, this embodiment also offers a simple means of providing facilities to ensure that the finished goods are despatched quickly and safely, by means of a truck, for example.

Another embodiment, defined in claims 51 and 52, offers advantages because contamination of the irradiated goods can be largely ruled out.

A high degree of safety can be guaranteed for the personnel operating the plant if using the embodiments described in claims 53 to 55.

The embodiment defined in claim 56 has advantages since it is possible to dimension the system proposed by the invention to meet the essential requirements of the conveyor system.

By virtue of another embodiment defined in claim 57, electrons can be accelerated to a high speed by simple means, thereby ensuring an adequate deposit of high-energy electrons.

With the embodiments outlined in claims 58 and 59, the electron beam is able to cover a large part of the surface area of the objects to be irradiated.

By dint of the embodiment described in claim 60, the objects to be irradiated can be processed from start to finish in a single pass. At the same time, this type of electron-emitting device can be used to accelerate the electrons.

The advantageous embodiments set out in claims 61 and 62 obviate the need for any awkward handling of the goods, in particular unpacking and re-packing.
Also of advantage is the embodiment defined in claim 63, since it allows larger objects to be irradiated without any detriment to the irradiation quality.

The embodiments outlined in claims 64 and 65 offer an advantage in that an electron beam can be provided whose energy and output reliably ensure that the desired effect is produced in the irradiated objects.

The advantage of the embodiments defined in claims 66 and 67 is that there is no need for a complicated system to move the objects to be irradiated.

Advantageously, the embodiments set out in claims 68 and 69 ensure that the radiation dose is uniformly distributed.

By accelerating the electrons with electromagnetic waves as described in claim 70, a high energy level can be imparted.

The advantage of the embodiments defined in claim 71 and 72 is that in order to produce electromagnetic waves to accelerate the electrons, a capacity is provided in which stationary waves can be propagated.

The embodiments defined in claims 73 to 75 offer advantages because the energy imparted to the electrons is so high that under-irradiation of the objects is virtually out of the question.

The embodiment defined in claim 76 ensures that moving system components are handled so as to be subjected to the least damage possible.

The advantage of the embodiment outlined in claim 77 is the high product turnaround and hence a shorter production time.

Also of advantage is another embodiment described in claim 78, whereby the object to be irradiated can be passed across the electron-emitting device again.

In accordance with the embodiments outlined in claims 79 and 80, the dose applied to the object is largely guaranteed to remain uniform if constant operating parameters are set for the accelerator unit.

Claim 81 proposes an embodiment whereby the conveyor system can be assembled using inexpensive and low maintenance individual components.

By splitting the overall conveyor system up into individual parts, as described in claim 82, an advantage is to be had since these parts can be set up depending on the respective beam load from the electron accelerator.

Claim 83 offers an advantageous embodiment because a position sensor ensures that the system proposed by the invention can be fully automated as far as possible.

By using a transverse carriage as a transverse conveyor as described in claim 84, it is possible to put together an inexpensive variant for this part of the conveyor system since the objects can be conveyed both into and out of the processing chamber.

In accordance with another embodiment outlined in claim 85, displacement of the goods through the electron beam can advantageously be adapted to suit prevailing requirements.

The advantage of the embodiment described in claim 86 is that it provides an easy means of feeding the irradiated objects out from the irradiation process.

Claims 87 to 90 describe advantageous embodiments whereby the objects can be individually handled, thereby providing an effective quality management system.

The embodiments described in claims 91 and 92 advantageously enable the individuality of the objects to be detected automatically.

In accordance with the embodiments proposed in claims 93 and 94, any interruption in the flow of goods due to fluctuations in the input region can be ruled out as far as possible.

By virtue of the advantageous embodiments set out in claims 95 and 96, the degree of automation of the system proposed by the invention can be increased still further and the operating safety of the automated system improved. Operating devices of this type enabling the goods to be halted provide a low-maintenance system which is stable in operation over long periods.

The embodiment described in claim 97 offers the advantageous and simple possibility of smooth operation of the conveyor system and the respective forward feed speeds required can be finely tuned to suit the properties of the object to be irradiated.

In accordance with the embodiments described in claims 98 and 99, an advantage is obtained because the degree of treatment which needs to be applied to the goods can be determined in a simple manner and the efficiency of the entire system improved accordingly.

By providing an Emergency-Stop switch in the region of the conveyor system as defined in claim 100, the safety of the plant can be further enhanced in the event of faults.

Claim 101 provides an advantageous embodiment whereby the objects to be irradiated are transported more safely by means of the conveyor system.

Another embodiment such as that described in claim 102 is possible, whereby the environment can be protected by improving the primary resources to generate heat.

Finally, the embodiment outlined in claim 103 is of advantage because the atmospheric conditions in the processing or irradiation chamber are maintained at a status compatible with human presence. In particular, splitting and reagent substances which occur when the surrounding air is irradiated with ionising radiation can be removed from said chambers.

The invention will be described in more detail below with reference to the embodiments illustrated in the drawings.

Of these:

Fig. 1 is a schematic and highly simplified diagram showing the layout of the system components used to produce and accelerate the electrons;

Fig. 2 is a schematic and simplified diagram of the layout of a plant as proposed by the invention;

Fig. 3 shows one embodiment of the conveyor system for a plant as proposed by the invention;

Fig. 4 shows another embodiment of the conveyor system, in a plan view;

Fig. 5 is a simplified diagram of an embodiment of the conveyor system in a plan view with multiple options for feeding the objects to be treated in and out of the system;

Fig. 6 shows another embodiment of a conveyor system for a plant as proposed by the invention;

Fig. 7 is a plan view of an embodiment for a plant of the type proposed by the invention, with separated regions for feeding the objects to be treated in and out;

Fig. 8 shows a plan view of the plant proposed by the invention with an additional encapsulated irradiation chamber;

Fig. 9 is a front view of an embodiment of a plant as proposed by the invention, viewed in section, having vertically disposed labyrinths for feeding the objects to be treated in and out;

Fig. 10 is a simplified, schematic diagram of an embodiment of the electron-emitting device.

Firstly, it should be pointed out that in the different embodiments described, the same parts are shown by the same reference numbers and referred to by the same component names and the disclosures made throughout the description can be transposed in terms of meaning to components bearing the same reference numbers or the same component names. Similarly, the description of positions chosen in the description, e.g. top, bottom, side, etc. relate directly to the drawing being

described and can be transposed in terms of meaning when a different position is being described. Furthermore, the individual features or combinations of features from the different embodiments described and illustrated may be regarded as independent, inventive solutions or solutions of the invention in their own right.

Fig. 1 is a schematic and simplified diagram showing the ground plan of an irradiating chamber 1 of a plant 2 of the type proposed by the invention. In order to keep the diagram simple and uncluttered, those parts of the system which are disposed above a level on which the ceiling of the irradiation chamber 1 is disposed are either not shown or are shown by broken lines. These parts of the system predominantly form part of a conveyor system 3.

The system components illustrated are preferably disposed underground, the advantage of this being that those parts of the system which are located above a level formed by a ceiling of the irradiation chamber 1 are less exposed to irradiation. Due to the fact that the earth surrounding the irradiation chamber 1 can be used as a protective radiation barrier, the structural components disposed above ground, such as the walls for example, may be of smaller dimensions than is generally the case in conventional plants, which, amongst other things, increases the economic viability of the plant 2.

Particularly fast-moving electrons are used to irradiate objects 4. These are preferably released from a linear accelerator 5 from an incandescent cathode 6 and initially accelerated in the direction of an anode due to the initially prevailing potential difference. Due to the linear accelerator 5 used by preference, outputs of between 5 kW and 40 kW, preferably between 10 kW and 30 kW, in particular 20 kW, can be achieved, thereby irradiating the objects 4 with electrons preferably carrying an energy of between 5 MeV and 30 MeV, preferably 10 MeV.

Clearly, it would also be possible to use several electron accelerator units in the plant 2, which may also be of varying constructions, in order to apply irradiation from several sides, for example. However, in order to provide a clearer understanding in the description below, this option will not be explained in any further detail, even though it remains within the scope of the invention.

Due to the fact that it is not possible to use an acceleration system with electrostatic fields such

as conventionally used in cathode ray tubes, for example, with an energy of ca. 30 kV because of these high energy levels, it is preferable if the electrons are finally accelerated by means of electromagnetic waves. Cavity resonators 7 may be used, for example, known as wave guides, to generate these electromagnetic waves along the acceleration path. Inside these cavity resonators 7, which may be made from metals such as copper, copper alloys such as bronze and brass, or from steel, ceramic, plastics or similar, a stationary wave is formed, whose field distribution is determined by the geometry of the cavity resonators 7 and the frequency of the microwave energy fed in.

The stationary wave in the accelerator unit is preferably excited by pulsed microwaves, which are generated by an oscillator 8, for examples, with an RF-driver, and amplified by a microwave amplifier 9, for example a klystron or similar. The energy required for this purpose is supplied by a high-voltage modulator 10, which is supplied from a primary energy source 11, for example the public power grid.

The frequency of the microwaves used lies within the GHz range, whilst the electrons emitted by the linear accelerator 5 have a pulse frequency of approximately 300 pulses per second.

At this stage, it should be pointed out that all other appropriate methods of accelerating electrons, known from the state of the art, may also be used. Above all, the design of a plant 2 as proposed by the invention is not restricted to the use of microwaves as an acceleration medium amplified by a klystron.

Accelerated in this manner, the electrons, which are preferably focussed by means of a quadrupole 12, are applied to the objects 4, provided a shutter 13 is open, in a defined, predetermined path, assisted by deflector magnets 14, once they leave an electron-emitting device 15, for example a scan-horn with a preferably rectangular cross-section, an annular electron-emitting device 15 or similar. As will be explained in more detail below, the objects 4 are moved with the aid of a conveyor system 3 through the electron beam emitted from the electron-emitting device 15. The shutter 13 is primarily provided as a means of preventing damage to the internal components of the linear accelerator 5 in the event that the electron emission window becomes damaged in the region of the electron-emitting device 15.

The dimensions of the electron-emitting device 15 are preferably selected so that a scan height of up to 100 cm, preferably 60 cm, can be achieved.

By preference, pulsed electrons are discharged from the electron-emitting device 15 and it is possible to set up the objects 4 and the conveyor system 3 so that there is a pulse overlap of at least 30%, preferably 50%.

At this stage, it should be pointed out that it would also be possible to assign several electron-emitting devices 15 to an electron accelerator unit.

For safety reasons, what is known as a beam-stop 17 may be provided behind the objects 4 in the emission direction of the linear accelerator 5, preferably mounted on a wall 16, and is preferably made from a metal plate with a high electron catchment cross-section, for example an aluminium plate, so that electrons potentially passing through can be decelerated, thereby giving rise to soft γ-radiation only.

Since humans need to be able to enter the irradiation chamber 1 for maintenance purposes, at least one venting device 18, for example a ventilator or similar, may be provided in order to maintain a compatible atmosphere in the irradiation chamber 1, thereby enabling any reaction products which might have formed due to the ambient air being exposed to ionising radiation can be evacuated from the irradiation chamber 1. As illustrated by the venting devices 18 shown by broken lines in Fig. 1, additional venting devices 18 may be provided in the plant 2 proposed by the invention.

Clearly, any accelerator unit known from the prior art could be used to accelerate the electrons. Accordingly, it would also be possible to use ring accelerators, for example.

The irradiation chamber 1 is preferably bounded by walls, made from steel-reinforced concrete, metal or similar, by means of which the surrounding area can be screened off from the irradiation chamber 1. Similarly, the floor plates and the ceiling plates of the irradiation chamber 1 may be made from these same materials. Since the irradiation chamber 1 is preferably built underground, the dimensions of these walls and floor plate as well as the ceiling in terms of thickness may be smaller, as mentioned above, since the surrounding earth also acts as a protective screen.

Because of the noise from the oscillator 8 and the microwave amplifier 9, it is of advantage if these modules in the plant 2 proposed by the invention are disposed in a room 19 which can be isolated from the irradiation chamber 1 by means of walls 20, 21, made from steel-reinforced concrete for example. This being the case, the link between the linear accelerator 5 and the microwave amplifier 9 through the cavity resonator 7 may be provided by means of an orifice 22 in the wall 21.

Clearly, in this connection, it would also be possible to take other steps to reduce the noise level. For example, individual system components which generate noise could be screened off separately. Similarly, there is also the option of providing sound-proofing plates in the walls 20, 21, for example.

In order to monitor the system remotely, it is of advantage if at least one observation camera 23 is provided in the irradiation chamber 1, connected to a control console for the plant 2. This will enable any irregularities to be picked up without delay, for example in the region of the conveyor system 3, so that the appropriate action can be taken.

Fig. 2 is a schematic and simplified diagram showing the ground plan of the plant 2 proposed by the invention. In order to retain overall clarity, parts of the system disposed on a level below the ceiling of the irradiation chamber 1 have been left out, with the exception of the linear accelerator 5 (which is partially indicated by broken lines in Fig. 2).

The conveyor system 3 illustrated in Fig. 2 is preferably split up into a feed buffer 24, a transverse conveyor 25, a delivery buffer 26 to a process chamber 27, a continuous conveyor 28, a process conveyor 29, a switch buffer 30 in the process chamber 27 and an additional buffer 31.

One advantage of the conveyor system 3 illustrated in Fig. 2 is that the objects 4 can be delivered to the irradiation chamber 1 in or on transport elements 32 which are also used for purposes other than to convey the objects 4 within the plant 2 proposed by the invention. Transport elements 32 of this type might be pallets, transport boxes with solid or pierced side walls or similar made from any material such as wood, plastics, metal, etc.. By preference, what are known as Euro pallets are used, complying the standard dimensions of a standing surface area of 1200 mm x 800

mm, of the type used as standard to transport objects 4 on the road by truck and by rail. Naturally, it would be possible to use any other form of transport element 32 of any dimensions, including in particular disposable pallets.

If pallets are used as the transport elements 32, the empty pallet weight may be between 1kg and 30 kg, for example, preferably 20 kg. To ensure optimum usage of the capacity of the plant 2 proposed by the invention, in particular the linear accelerator 5, the loaded pallet weight may be in the region of between 300 kg and 700 kg, preferably 500 kg. Clearly, these weight specifications are given as a guideline only since a minimum weight restriction of 0 kg must be applied and the maximum weight restriction will depend on the design of the conveyor system 3.

The feed buffer 24 may consist of individual drive positions, preferably 15 of them. Accordingly, at least one drive device 33 is assigned to every individual drive position, for example a motor, in particular a servo-motor. In addition, at least one position sensor 34 may be mounted on each individual drive position, for example a light sensor, an electric sensor, a magnetic sensor or similar. As a result, given that the conveyor system illustrated in Fig. 2 is essentially designed as a discontinuous process, as soon as a transport element 32 is transferred from the feed buffer 24 to the transverse conveyor 25, the position sensor 34 will detect that at least one individual drive position is empty. For example, a signal could be emitted from the light sensor 35 to a control and drive unit 36, preferably centrally located (in Fig. 2 this is indicated by a broken line connecting a light sensor to the control and drive unit 36), so that the drive devices 33 are actuated and the transport elements 32 shifted respectively by one position in the direction of the process chamber 27. A feed position 36will therefore become free and another transport element 32 can be delivered to the feed buffer 24.

The feed position 37 may preferably consist of a lift table with integrated roller track. This advantage of this is that transport elements 32 can be fed in a simple manner through a stacker, for example, to the feed buffer 24.

The feed buffer 24 may be separated from the buffer 31 by means of a separator device 38, for example a wall, a grating or similar. Accordingly, the unclean feed region can be separated off from the clean despatch region.

An express feed point for transport elements 32 can be integrated in the feed buffer 24, for example at a position 39. As a result, individual transport elements 32 can be processed with a shorter throughput time. If an express feed point of this type is used, the control and drive unit 36 can disable the transport of objects 4 onto the feed buffer 24 and along to the express feed point until the latter is free again. This may be detected automatically - as can the presence of objects 4 at the express feed point - by means of the above-mentioned position sensors 34, for example.

From the feed buffer 24, the transport elements 32 are transferred to the transverse conveyor 25. This may be made up of transverse carriages 40. This transverse carriage 40 preferably has a roller track and runs on rails 41. Accordingly, it will be possible to pick up individual transport elements 32 and deliver them through a labyrinth 42 to the delivery buffer 26.

The materials selected for the conveyor system 3 and the drive devices 33 and position sensors 34 are preferably adapted to the requirements of the radiation technology used in the process chamber 27 and irradiation chamber 1. The advantage of this is that the plant 2 proposed by the invention will be able to operate as far as possible fault-free. Furthermore, the times between maintenance inspections of the individual components of the plant 2 can be lengthened by selecting appropriate materials.

At least one drive device 33 is assigned to the transverse conveyor 25 so that it can be displaced along a run 43. Furthermore, position sensors 34 may be provided along this run 43 in the vicinity of the transverse conveyor 25 which are in turn connected to the central control and drive unit 36. Clearly, however, it would also be possible for each position sensor 34 to have its own decentralised control and drive unit. With these position sensors 34, if a transverse carriage 40 is used for the transverse conveyor 25 for example, it can be displaced accurately to the individual positions along the run 43 so that the transport elements 32 can be transferred between the different parts of the conveyor system 3, for example the feed buffer and the delivery buffer 26 as well as the switch buffer 30 and the buffer 31.

For economic reasons and because the conveyor system 3 illustrated in Fig. 2 is operated discontinuously, it is of advantage if only one transverse conveyor 25 is provided in the labyrinth 42, in which case it will be used both to deliver objects 4 to the process chamber 27 and feed them away from the process chamber 27. However, this does not rule out the fact that it would also be

possible to provide separate transverse conveyors feeding the objects 4 in and out of the labyrinth 42. In order to enable sections of the conveyor system to be displaced in at least two directions, frequency transformers may be provided on the appropriate drive devices 33.

Advantageously, the capacity of the transverse conveyor 25 may be selected so that the objects 4 are delivered to and transported away from the process chamber 27 in a time ranging between 1 min. and 10 min., preferably 3 min.. As a result, the speed of the conveyor system 3 can be optimally set to the time taken to irradiate objects 4, which are preferably disposed on transport elements 32, thereby making the plant 2 more economical to run.

From the transverse conveyor 25, the transport elements 32 are transferred to the delivery buffer 26. As indicated in Fig. 2, this may consist of individual drive positions, each having its own separate integrated drive device 33 and position sensor 34. On the other hand, however, it would also be possible to set the delivery buffer 26 up as a continuous conveyor, using roller conveyors, belt conveyors, chain conveyors, bar conveyors or similar, for example. This being the case, it would also be possible, as illustrated in Fig. 2, to use a combination of several different types of conveyor for the delivery buffer 26, such as a combination of individual drive positions and a chain conveyor 44 or tracks comprising individual rollers or roller tracks. A combined conveyor system of this type could also be used for all the other sections of the conveyor system 3.

As mentioned above, the individual drive devices 33 and position sensors 34 are connected to a central control and drive unit 36 or these devices may be connected to a de-centralised control and drive.

It has proved particularly effective to use chain conveyors in the process chamber 27 since these conveyors are as far as possible insensitive to ionising radiation which means that the plant 2 will be more economical since the times between maintenance inspections can be lengthened, as mentioned earlier. Therefore, it is preferable to use chain conveyors 44 if operating a continuous conveyor 28. Clearly, however, instead of the chain conveyor 44, it would also be possible to use any other conveyor component for a continuous conveyor 28. Instead of the continuous conveyor 28, it would also be conceivable to use conveyors operated on a discontinuous basis.

In order to compensate for the difference in levels between the delivery buffer 26 and the con-

tinuous conveyor 28 enabling the transport elements 32 to be transferred from the delivery buffer 26 to the continuous conveyor 28, it is preferable to provide a lowering and raising device 46 at a transfer region 45 in order to turn corners.

Clearly, instead of designing the continuous conveyor 28 end to end as illustrated in Fig. 2, it would also be possible to build it using several individual conveyors.

From the continuous conveyor 28, the transport elements 32 are transferred to a conveyor 47 and a raising and lowering device 46 may be provided in the transfer region 45 for the reasons explained above. This raising and lower device 46 is preferably operated whenever a position sensor 34, for example a light sensor 35, is interrupted by a transport element 32.

The conveyor 47 is also preferably a continuous conveyor and can be built using the components mentioned above, in particular a chain conveyor 44.

Farther along the system, in a second transfer region 45 with an adjoining raising and lower device 46, preferably arranged on the side of the conveyor 47 lying opposite the first transfer region, the transport elements 32 are transferred to a process delivery conveyor 48, which is preferably also built using the components described above. This process delivery conveyor 48 delivers the transport elements 32 to a process conveyor 29.

The process conveyor 29 is preferably a rotary lifting table 49. Accordingly, the objects 4 to be irradiated can be fed past the electron-emitting device 15 of the linear accelerator 5 by effecting a rotary motion whilst simultaneously displacing the rotary lifting table 49 in a vertical motion so that irradiation can be applied by the electron beam.

At least one drive device 33 and a position sensor 34 are assigned to the rotary lifting table 49 so that when the presence of a transport element 32 is detected on the rotary lifting table 49, the latter can be set in motion by the drive device 33.

Other conveyor elements such as transport rollers, rails or similar, may also be provided on the rotary lifting table 49, enabling simple and rapid positioning of the transport element 32 on the rotary lifting table 49.

Clearly, it would also be possible to use other combinations for displacing the rotary lifting table 49 and individual types of motion. For example, the rotary lifting table 49 might be moved by a specific distance in a vertical direction, preferably downwards and then rotated in order to irradiate the objects 4 on the transport elements 32 with electrons from all sides. To this end, it is of advantage if position sensors 34 are mounted along the path along which the rotary lifting table 49 can be displaced in a vertical direction, thereby ensuring accurate vertical displacement of the rotary lifting table 49. By preference, the distances of the vertical displacement of the rotary lifting table 49 are set to the maximum height of the electron-emitting device 15. However, it would also be possible for the rotary lifting table 49 to travel distances such that an overlap is produced with the irradiation surfaces (the surfaces of the objects 4) relative to the maximum scanning height. This would expose the objects 4 to radiation several times on the one hand and on the other would enable the linear accelerator 5 to be used with operating parameters below the maximum load limit of the linear accelerator 5, thereby honing operation of the plant 2 proposed by the invention.

Naturally, it would also be possible, if appropriate to the objects 4, particularly if they were very narrow upstanding objects 4, to displace the rotary lifting table 49 in a vertical direction only. However, it would also be possible to displace the rotary lifting table 49 in many other ways, which will not be described here.

It is of particular advantage if the objects 4 on the transport elements 32 are irradiated by electrons whilst both raising the rotary lifting table 49 to the level of the process delivery conveyor 48 and simultaneously rotating it, so that irradiation could be applied from all angles, resulting in the advantages described above with regard to the linear accelerator 5.

It may also be of advantage to assign a position sensor 34 to the rotary lifting table 49, by means of which any inadvertent interruption to the irradiation process can be detected at any point at which insufficient radiation has been applied. Specifically, it is not possible for the drive devices 33 to bring the process conveyor 29 to an immediate standstill and it may be that regions of the objects 4 to which radiation has just been applied have not been sufficiently treated. Using the data from the position sensor 34, the process conveyor 29 will be able to return to the position in question once the linear accelerator is restored to full output, thereby guaranteeing the quality of

the irradiation process.

However, the greatest advantage is to be had if the drive device 33 of the process conveyor 29 is able to effect an immediate halt as soon as a defect is detected in the accelerator unit.
As soon as the process conveyor 29 has reached is loading and unloading position, the accelerator is switched off or switched to stand-by operation in order to increase safety of the plant 2. However, this is not an absolute requirement and is merely offered for the safety of the plant 2, as mentioned, or to avoid any unnecessary ionisation of the air in the irradiation chamber 1.

From the process conveyor 29, the objects 4 are transferred to the transport elements 32 at a process discharge conveyor 50, which may consist of the above-mentioned conveyor components of the conveyor system 3, in particular those described in relation to the process delivery conveyor 48.

Further on, the transport elements 32 can be transferred to the switch buffer 30 in a transfer region 45 using the lowering and raising device 46 described above. This switch buffer 30, which is preferably designed to handle four transport elements 32 (shown by broken lines in Fig. 2), transfers the transport elements 32 to the transverse conveyor 25. On the transverse conveyor 25, the transverse carriages 40 described above can pick up the irradiated transport elements 32 with the objects 4 and deliver them to the buffer 31.

It is particularly advantageous if the logistics of the conveyor system 3, in particular the transverse carriage 40, are designed so that the transport elements 32 are delivered to the delivery buffer 26 in one direction as indicated by arrow 51 and then with a displacement of the transverse carriage 40 in the direction of arrow 52, irradiated objects 4 are removed from the switch buffer 30 on transport elements 32. By using this logistical set-up, the transport time of the transverse carriage 40 can advantageously be reduced to almost 50% of the maximum required carriage time.

To enable the plant 2 proposed by the invention to be automated as far as possible, the elements mentioned above, such as drive devices 33 and position sensor 34 may be mounted along the conveyor run of the process discharge conveyor 50 and the switch buffer 30.

The buffer 31 may be designed as a continuous conveyor of any type known from the prior art and it would also be possible to use a discontinuous conveyor as an alternative. By preference, the buffer 31 consists of a gravity track, preferably having sixteen places, with place No. 16 disposed flush with the plane of the stack despatch point 53.

Clearly, it would also be possible, instead of transporting the objects 4 in transport elements 32 as described above, to carry them individually without any packaging, to the irradiation process.

In order to increase the operating safety of the system 1 proposed by the invention, a protective device 54 may be provided where the conveyor system 3 enters the process chamber 27, which might take the form of a dividing wall, an appropriate grating arrangement or similar, with a door 55 mounted therein. This will largely prevent unauthorised access to the process chamber 27. Additional measures might also be taken and electronic lock system could be provided on a door 55 mounted in the protective device, for example, to prevent access to the process chamber 27 if the accelerator unit is emitting electrons. By preference, an Emergency-Stop switch 56 can be provided on the door 55. It would also be conceivable to provide other Emergency-Stop 56 switches at other points around the plant 2.

However, it would also be possible to set up the control system of the accelerator unit so that sensors, operating on the basis of an electrical contact, an optical sensor or similar, in the frame of the door 55 of the processing entrance could be automatically interrupted when the door 55 is opened, thereby ruling out virtually 100% any potential risk to persons due to electron emissions. As an additional safety feature, a cable pull switch 57 can be provided at least along a partial stretch of the conveyor system 3, for example. This would enable personnel who had inadvertently entered the process chamber 27 when the accelerator unit was activated to halt the irradiation process and, provided the control and drive unit 36 were set up accordingly for the accelerator unit, to indicate to the control and drive device 36 via the cable pull switch 57, by sounding an optional acoustic warning signal, that the linear accelerator 5 should be switched to stand-by mode. In addition, it would also be possible to provide electrical contacts, for example, in a door mat behind the door 55 or in the labyrinthine entrance in order to detect when persons are entering the process chamber 27 whilst the accelerator unit is in operation. This will naturally mean that the dimensions of the door mat must be selected so that it will not be possible to step over it.

Clearly, light sensor units could also be mounted at specific points around the plant 2, for example in the vicinity of the door 55, in order to monitor access to the process chamber 27.

Safety of the plant 2 can be increased, for example, by providing a beam interrupter in the path of the beam of the accelerator unit by means of which unintentional emissions of electrons can also be prevented.

Other standard sensors and warning devices such as motion sensors, rotating mirrors, alarm horns, could, of course, also be positioned at any point in the plant 2.

It has also proved to be particularly effective if, as mentioned above, observation cameras 23 are placed at nodal points around the plant 2, by means of which the process chamber 27 and the irradiation chamber 1 as well the individual parts of the labyrinthine access system and the conveyor system 3 can be monitored.

A control console 58 with an Emergency Stop switch 56 is provided in the vicinity of the feed buffer 24. A control console 58 of this type may also be provided at position 39 in the region of the express feed point in order to enable the objects 4 to be despatched rapidly.

The objects 4 on the transport elements 32 may be fed from the regions in which the feed buffer 24 is driven past at least one marker device 59, for example a label dispenser, a device for applying microchips, an ink jet printer or similar, so that they can be simultaneously identified. This marker device 59 may be positioned at any appropriate point along the feed buffer 24. The marker device 59 may co-operate with a pressing device such as a roller, a brush or similar, for labels for example. Instead of identifying the objects 4 in the transport elements 32, it would also be possible to identify both the objects 4 and the transport elements 32. In order to detect the objects 4 and the transport elements 32 automatically and in order to process the recorded data, as preferred, in an EDP system, a scanner 60 may be provided at the feed buffer 24, for example a reader. A scanner 60 of this type may also be located at the buffer 31, for example, which might be used to detect the stage of processing which the objects 4 have reached or detect the presence of tagged objects 4.

If microchips are used as a means of tagging the objects, it would also be possible to fit these with a transmitter, for example an IR transmitter, from which data specific to the objects could be transmitted to a receiver unit, preferably mounted in the region of the conveyor system 3.

All the data, in particular the data picked up by sensors, can advantageously be transmitted by optical fibres, thereby avoiding any interference from the accelerator unit during data transmission.

By preference, the heat built up during processing is recycled in a manner known from the prior art by means of an appropriate heat exchanger and fed back into the process system.

Figs. 3 to 6 provide simplified, schematic diagrams in plan view of other embodiments of conveyor systems 3 which may be used with the plant 2 proposed by the invention.

Fig. 3 illustrates one option for replacing the switch buffer 30 illustrated in Fig. 2. For example, the delivery buffer 26 may be designed as a continuous conveyor, for example a roller track, a chain conveyor or similar. This continuous conveyor is provided with drive devices 33 so that it can be operated in both directions across a length 61 as indicated by the double arrow 62. Accordingly, the irradiated objects 4 on the transport elements 32 will no longer be transferred from the process discharge conveyor 50 to a switch buffer 30 as illustrated in Fig. 2 but instead will be transferred back to the delivery buffer 26, with which they can be fed out of the process chamber 27 in co-operation with the transverse conveyor 25, which can also be operated in both directions as indicated by the double arrow 62. In order to enable the transport elements 32 to be moved into the special regions of the conveyor system 3, especially into the corners, raising and lowering devices 46 can again be provided in all transfer regions 45. Furthermore, individual elements of the conveyor system 3 and the position sensors 34 assigned to them as illustrated in Fig. 2, and the components assigned to the conveyor system 3 illustrated in Fig. 2 may also be used with the conveyor system 3 illustrated in Fig. 3 even though these are not actually shown in the drawing.

Fig. 3 also illustrates an option whereby the process conveyor 29 may be installed at a different point than that in the process chamber 27 illustrated in Fig. 2.

Using the conveyor system 3 illustrated in Fig. 3, not only is it possible to increase the economic

efficiency of the plant 2 - as mentioned above, the switch buffer 30 illustrated in Fig. 2 can be dispensed with - the objects 4 can also be exposed to radiation more than once on the transport elements 32, in which case they are not despatched from the delivery buffer 26 after the first irradiation process across length 61 but are returned to the irradiation process via the process delivery conveyor 48 as indicated by arrow 63.

Clearly, it would also be possible to use all the parts of the plant 2 illustrated in Fig. 1 and Fig. 2, for example the separator device 38, the protective device 54, both in the plant 2 illustrated in Fig. 3 and the plant 2 illustrated in Fig. 4 to Fig. 6. For this reason, only the conveyor system 3 illustrated in Figs. 4 to 6 will be described.

Fig. 4 is a schematic diagram of another possible structure of the conveyor system 3 for a plant 2 as proposed by the invention. In this case, a transverse carriage 40 is preferably used for the transverse conveyor 25 but in order to increase the capacity of the conveyor system 3, at least two transverse carriages 40 are used. By preference, a separate transverse carriage 40 is provided for the feed buffer 24 which transfers the objects 4 on the transport elements 32 to the delivery buffer 26 and a transverse carriage 40 for the buffer 31 so that the transport elements 32 located on the switch buffer 30 can be conveyed independently of the transverse carriage 40 of the feed buffer 24.

However, if opting to provide separate transverse carriages 40, this will still not rule out the possibility of coupling the two transverse carriages with one another, although the distance between the two transverse carriages 40 must be adapted to the distance of the feed buffer 24 from the buffer 31 and the delivery buffer 26 from the switch buffer 30.

The embodiment of a conveyor system 3 for the plant 2 illustrated in Fig. 5 shows another possible way of increasing the capacity of the plant 2. In this case, both the feed buffer 24 and the buffer 31 are preferably split up in two separate regions 64 and 65. Consequently, it is possible to design the feed buffer 24 o the one hand and/or the buffer 31 on the other hand in at least two parts in the region 64 so that there are at least two separate feed positions 37 on the feed buffer 24 and/or two separate receiving positions 66 on the buffer 31. Furthermore, in the region 64 of the feed buffer 24, an express feed point 67 may be provided to enable individual objects 4 to be treated on transport elements 32.

In order to transfer the objects 4 on the transport elements 32 on the one hand from the region 64 of the feed buffer 24 to the region 65 assigned thereto and from the region 65 to the region 64 assigned to the buffer 31 in readiness for despatch, either a continuous conveyor may be used or, as illustrated in Fig. 5, an additional transverse conveyor 25, for example a transverse carriage 40. Clearly, it would of course also be possible to use several transverse carriages 40.
The conveyor system 3 for the plant 2 schematically illustrated in Fig. 6 shows a simple means of separating at least some parts of the unclean feed buffer 24 from the buffer 31, simultaneously affording ready access of the feed buffer 24 and the buffer 31 from several sides, for maintenance work for example. This separation is preferably provided in the form of a separator device 38.

An embodiment of the conveyor system 3 of this type is preferably used if a coupled transverse carriage 40 (shown separately in Fig. 6 due to the chosen design of the parts of the conveyor system 3 in the process chamber 27) is used so that the objects 4 can be delivered on transport elements 32 to the delivery buffer 26, after which the objects 4 can be fed away from the despatch buffer 30 (not illustrated in Fig. 6) whilst requiring only a small surface area of the process chamber 27.

The embodiment of a plant 2 proposed by the invention and illustrated in a simplified and schematic diagram from a plan view in Fig. 7 (to provide a clearer overall view, those components which are preferably located underground have been left out) provides a simple means of incorporating the plant 2 proposed by the invention in a production line, for example.

Again, the objects 4 are delivered on the transport elements 32 via the feed buffer 24, which transfers the transport elements 32 with the objects 4 in the inlet region 68 of the labyrinth 42 to the other part of the conveyor system 3. By contrast with the embodiments described until now, an outlet region 69 of a second labyrinth is located at another point of the plant 2 than the first labyrinth 42 of the inlet region 68. By preference, the inlet region 68 and the outlet region 69 are arranged lying opposite one another within the plant 2.

By setting the conveyor system 3 up in this way, the separation between the unclean feed buffer 24 and the clean buffer 31 is improved.

Otherwise, the individual parts of the conveyor system may be made up of the same components as those described above and may be assigned to the relevant parts of the system as explained above.

Fig. 8 is a simplified, schematic illustration of another embodiment of a plant 2 proposed by the invention, seen in a plan view. Due to the fact that the accelerator unit, in particular the linear accelerator 5, is disposed underground by preference and the surrounding earth can be used as a screen, the provision of a labyrinthine access to the process chamber 27 can readily be dispensed with, particularly in plants 2 operating at a low output. Instead of a labyrinth 42, the region in which the process conveyor 29 is disposed, e.g. the rotary lifting table 49, may be secured by additional structural means as illustrated in Fig. 8. For example, in one variant, an additional housing 70 can be provided over the process conveyor 29. All materials suitable for this particular application may be used for this housing 70, for example steel-reinforced concrete with or without additional metal cladding. By preference, metals which have a high cross section in terms of capturing electrons will be used.

If the conveyor system 3 is of the design illustrated in Fig. 8, for example with regard to the link between the plant 2 and a production line, housing orifices 71 may be provided on opposing faces of the housing 70 so that the objects 4 on transport elements 32 can be fed to the process conveyor 29.

This being the case, the dimensions of the housing orifices 71 preferably match the maximum dimensions of the transport elements 32 with the objects 4.

Clearly, as opposed to the system illustrated in Fig. 8, it would also be possible to arrange the entrance to and the exit from the process chamber 27 on the same side of the plant 2 and by structuring the conveyor system 3 accordingly, it would be possible to provide only one delivery buffer 26, which would also take charge of feeding the transport elements 32 and the objects 4 away.

Fig. 9 shows a cross section of an embodiment of the plant 2 proposed by the invention which offers another possible way in which the plant 2 can be incorporated with a production line. Instead of a horizontal labyrinth 42, as illustrated in the preceding drawings, the embodiment illus-

trated in Fig. 9 has a vertical labyrinth 42. This embodiment provides a cost-effective and space-saving plant 2, which is particularly desirable if incorporating a production line. Objects 4 located on the transport elements 32 are transferred from the feed buffer 24 to a first lifting device 46, which feeds the objects 4 into the irradiation chamber 1. There, they are picked up by the process conveyor 48 and are transferred to the process conveyor 29 by means of the rotary lifting table 49, for example. Here, as described above, they are fed by a combined vertical and rotating movement past the electron-emitting device 15 of the linear accelerator 5 so as to be irradiated. Once irradiated, which may take place both as the objects 4 are being raised and lowered, they are removed from the irradiation processing area via the process discharge conveyor 50, a third lifting device 46 and the buffer 31.

The irradiation process can be controlled with the aid of positions sensors 34 described above but not illustrated in Fig. 9, which in turn control drive devices 33.

Clearly, instead of two separate labyrinths 42, it would also be possible to provide only one, both for delivering and feeding the objects 4 to and away from the irradiation chamber 1. Individual parts of the conveyor system 3 may be used both for delivering and feeding away the objects 4 and it would be possible to provide two separate conveyor lines adjacent to one another.

Fig. 10, finally, is a simplified schematic illustration of an embodiment of the electron-emitting device 15. The electron-emitting device 15 of an electron accelerator 72, in particular the linear accelerator 5, is provided in the form of a circle, as can be seen from the plan view shown in Fig. 10. In order to deflect the electrons, deflector devices 73 may be provided, for example along the outer circumference of the electron-emitting device 15, such as electric coils which, in accordance with the laws of electromagnetism, build up a magnetic field from conductors through which current is flowing. Beam stops 17 may also be provided on the inner circumference of the electron-emitting device 15 (not illustrated in Fig. 10).

With an electron-emitting device 15 of this design, there is no need for the process conveyor 29 to be displaced in a rotating motion and the objects 4 on the transport elements 32 will be irradiated during a vertical displacement. This may be effects during both the lowering and raising movement of the process conveyor 29. Clearly, it would also be possible for the process conveyor 29 to perform a combined vertical and rotating motion during the irradiation process.

The approach described below has proved to be a particularly effective method of irradiating objects 4 on transport elements 32 although it is not restrictive and can be modified as required.

The object 4 to be irradiated is fed across the unclean feed buffer 24, in particular the feed position 37, to the conveyor system 3. This may be done manually by picking up the objects 4 from transport elements 32, for example pallets, and shifting the objects 4 onto transport elements 32 on the feed buffer 24.

By preference, however, transport elements 32 are used which have been ready-loaded with objects 4, by means of a production process, and made ready for transportation, for example by truck. These may also be shrink-wrapped.

In order to identify the objects 4 and/or the transport elements 32 individually, they are fed past a marker device 59, for example a label dispenser, an ink jet printer or similar. Having been applied in this manner, these markings, which may be a bar code for example, are detected by a downstream scanner 60 and this data is fed to a control and/or drive device 36, for example an EDP system.

The objects 4 are then fed across the individual parts of the conveyor system 3 into the process chamber 27 before being taken into the irradiation chamber 1. In order to determine the dose of radiation energy to be applied to the objects 4, it is important that the feed rate of the process conveyor 29 is adapted to the cyclical frequency of the electron pulses of the electron accelerator unit. Since the electrons are accelerated by electromagnetic waves of a predefined frequency, present as stationary waves in cavity resonators 7, and excited by a pulsed microwave generated by an oscillator 8 and amplified by a microwave amplifier 9, for example a klystron or similar, it has proved advantageous if the pulses of the electron beam overlap by at least 30%, preferably 50%. Accordingly, a dose can be uniformly distributed in the object 4.

It is of advantage to use an accelerator system in which a beam energy in the region of 5 MeV to 30 MeV, preferably 10 MeV, is used and a mean beam output in the region of 5 kW to 40 kW, preferably 10 kW to 30 kW, in particular 20 kW.

The feed rate of the process conveyor 29, in particular the rotary lifting table 49, should be between 1 revolution/s and 1 revolution/5 s, preferably 1 revolution/3 s.

The object 4 is preferably irradiated parallel with the direction of a partial displacement of the object 4 on the process conveyor 29 although irradiation may be from all sides, especially if several electron accelerators are used. In the latter case, the object 4 may be irradiated from all sides on an alternating basis or simultaneously.
Once irradiated, the object 4 is transported through the labyrinthine access out of the irradiation chamber 1 and the process chamber 27 and on past an identification system, for example a scanner 60, in particular a reading head. The data picked up may also be applied to an EDP system, which will therefore be able to ascertain the degree to which the object 4 has been treated. If it is necessary to irradiate the object 4 more than once, this data will be applied to the individual drive devices 33, which, in conjunction with the transverse conveyor 25, will cause the objects 4 on the feed buffer 24 to be held back in the process chamber 27 instead of being transported farther. The objects 4 located on the feed buffer 24 can be held back by means of a first stop, which can be positioned at the transfer region between the feed buffer 24 and the transverse conveyor 25, and buffered until the first irradiated object 4 is transferred from the transverse conveyor 25 to the buffer 31. The multiple irradiation process will be detected by the scanner 60.

If the conveyor system 3 were structured accordingly, as illustrated in fig. 3 for example, it would also be possible to buffer the objects 4 on the transport elements 32 at a different point in the transport system.

By specifically designing the process conveyor 29 as a rotary lifting table 49, the objects 4 could be irradiated several times using the motion sequence of the process conveyor 29, which would obviate the need for the objects 4 to be additionally buffered at various points of the conveyor system 3.

By controlling the system in this way, the capacity of the resources available could advantageously be used effectively. Optionally, in addition to the first stop, other stops could be mounted across the length of the conveyor system 3. Preferably, these would be positioned before each change of direction in the transport system. As a result, the objects 4 would be buffered so that a situation in which the capacity of the process conveyor 29 is not efficiently used would be

avoided. The objects 4 are released from each of the stops at defined intervals, timed to coincide with the dose of radiation to be applied.

In specific cases, the repeated change in the direction of displacement of the objects 4, i.e. of parts of the conveyor system 3, in particular the process conveyor 29, could be used to apply the necessary dose of radiation to the objects 4 several times as they are fed past the electron beam.

Usually, the objects 4 are fed into and out of the process chamber 27 from one side of the process chamber 27. However, it would also be possible for the objects 4 to be fed in and out of the process chamber 27 from different sides of the process chamber 27.

To determine the dose required for individual objects 4, dosimeters, for example radio-chromium film meters, could be mounted on individual objects 4 at significant points and these objects exposed to the radiation process. These significant points might be those points at which a higher or lower dose is needed. This is likely to be the case with the interior, but also the corner regions of the objects 4, especially if the objects 4 are irradiated in a packaging, for example their original packaging, so that the dosimeters used can preferably be placed at these points.

Radio-chromium film meters are excellent because their colour changes depending on the irradiation time and the dose to be administered. This colour change can therefore be measured by means of a spectral photometer by measuring the drop in intensity of a light beam passing through or its reflection. The resultant values can be used to work out the exact speed at which the process conveyor 29 needs to be fed along at a constant beam output. Alanine transfer dosimeters have proved to be of particular advantage in determining the calibration curve for evaluating the films. Clearly, however, any other methods could be used for calibration purposes.

In addition to radio-chromium film dosimeters, other dose meters could be used to enhance safety, preferably calorimetric dose meters.

To improve safety still further, additional film dosimeters could be attached to objects 4 at defined intervals along the route of the production process, preferably dosimeters carrying the same marker or identification as that used for the objects 4. This would prevent the individual film dose meters from being mixed up later. The objects 4 fitted with the additional dosimeters can be

recognised by means of a control and/or drive device 36 by means of a scanner 60, for example.

For the purposes of subsequent processing and in order to control the stability of the process, the data obtained from the dosimeters could be applied to a data processing system, by which it could archived.

The advantage of using a plant 2 proposed by the invention is that objects 4 of different types can be processed and their properties altered in part-regions. For example, products of different types can be sterilised.

This might include, amongst others, OP equipment, OP cladding, bonding substances, OP waste, pharmaceutical raw materials, pharmaceutical packaging, containers made from plastics and/or glass, test containers and laboratory equipment for the biotechnology sector, the sterilisation of liquids, recycled materials and refuse in the environmental technology sector, the removal of germs from plastics, the sterilisation of and removal of germs from spices, raw materials, products, beverages, seals and the sterilisation of packaging, containers or receptacles in packaging technology.

However, apart from sterilisation, there is a whole range of possible applications for a plant 2 of the type proposed by the invention. These might include the treatment of surfaces, for example by curing, curing and cross-linking plastics, setting and cross-linking varnishes. By selecting an appropriate transport system, for example in the form of bottles, even liquids, e.g. beer, water or similar, and gases can be irradiated in this manner. Bulk commodities and granulates of the most varied type can also be irradiated using the plant 2 proposed by the invention.

For the sake of good order, it should be pointed out that in order to provide a clearer understanding of the structure of the embodiments which might be used for a plant 2 of the type proposed by the invention, it and its component parts are illustrated to a certain extent out of scale and/or on an enlarged and/or reduced scale.

The task underlying the independent solutions of the invention can be taken from the description.

In particular, the individual embodiments illustrated in Figs. 1,2; 3; 4; 5; 6; 7; 8; 9; 10 may form

the subject-matter of independent solutions to the invention in their own right. The tasks set and solutions proposed by the invention are to be found in the detailed descriptions of these drawings.

Individual parts of the combinations of features described above with respect to the individual embodiments may also be used in conjunction with other individual features from other embodiments and may be regarded as independent solutions to the invention in their own right.

List of reference numbers

1	Irradiation chamber
2	Plant
3	Conveyor system
4	Object
5	Linear accelerator
6	Incandescent cathode
7	Cavity resonator
8	Oscillator
9	Microwave amplifier
10	High voltage modulator
11	Energy source
12	Quadrupole
13	Shutter
14	Deflector magnet
15	Electron-emitting device
16	Wall
17	Beam stop
18	Venting device
19	Room
20	Wall
21	Wall
22	Orifice
23	Observation camera
24	Feed buffer
25	Transverse conveyor
26	Delivery buffer
27	Process chamber
28	Continuous conveyor
29	Process conveyor
30	Switch buffer
31	Buffer

32	Transport element
33	Drive device
34	Position sensor
35	Light sensor
36	Control device
37	Feed position
38	Separator device
39	Position
40	Transverse carriage
41	Rail
42	Labyrinth
43	Run
44	Chain conveyor
45	Transfer region
46	Lifting device
47	Conveyor
48	Process delivery conveyor
49	Rotary lifting table
50	Process discharge conveyor
51	Arrow
52	Arrow
53	Stack despatch point
54	Protective device
55	Door
56	Emergency-Stop switch
57	Cable pull switch
58	Control console
59	Marker device
60	Scanner
61	Length
62	Double arrow
63	Arrow
64	Region

65	Region
66	Receiving positions
67	Express feed position
68	Inlet region
69	Outlet region
70	Housing
71	Housing orifice
72	Electron accelerator
73	Deflector device

Claims

1. A method of irradiating an object, in particular a material, an item of waste, a component, a foodstuff, a liquid, a gas or similar, whereby the object is displaced by means of a conveyor system through a beam of particles emitted from at least one radiation device, in particular an electron accelerator, in an irradiating chamber, characterised in that the electrons from an incandescent cathode needed for irradiation purposes are focussed and pulsed in an accelerator unit with waves of a specific, pre-definable frequency and are emitted from the electron-emitting device at a specific frequency and directed onto the object to be irradiated.

2. A method as claimed in claim 1, characterised in that electromagnetic waves are used to accelerate the electrons.

3. A method as claimed in claim 1 or 2, characterised in that cavity resonators are used to generate the electromagnetic waves.

4. A method as claimed in one or more of the preceding claims, characterised in that the stationary wave is excited by a pulsed microwave in the accelerator unit.

5. A method as claimed in one or more of the preceding claims, characterised in that the pulsed microwaves are generated by an oscillator and preferably amplified by a klystron.

6. A method as claimed in one or more of the preceding claims, characterised in that the feed rate of at least a part of the conveyor system is set up on the basis of the scanning rate and the number of pulses as well as the pulse period, such that the pulses of the electron beam overlap by at least 30%, preferably 50%.

7. A method as claimed in one or more of the preceding claims, characterised in that the electrons are beamed at an energy of 5 MeV to 30 MeV, preferably 10 MeV.

8. A method as claimed in one or more of the preceding claims, characterised in that the feed rate of the conveyor system is preferably set to fit in with the layout of buffers and the residence time of the object on the process conveyor.

9. A method as claimed in one or more of the preceding claims, characterised in that the process conveyor effects a vertical displacement through the electron beam.

10. A method as claimed in one or more of the preceding claims, characterised in that the process conveyor is designed to effect a displacement combining a vertical and a rotary movement during irradiation.

11. A method as claimed in one or more of the preceding claims, characterised in that a mean beam output in the range of 5 kW to 40 kW, preferably between 10 kW and 30 kW, in particular 20 kW, is used.

12. A method as claimed in one or more of the preceding claims, characterised in that the object is irradiated more or less parallel with a direction of displacement of the object.

13. A method as claimed in one or more of the preceding claims, characterised in that the object is irradiated more or less perpendicular to a direction of displacement of the object.

14. A method as claimed in one or more of the preceding claims, characterised in that the object is irradiated both during a downward and an upward displacement.

15. A method as claimed in one or more of the preceding claims, characterised in that several electron accelerators are used to irradiate the object.

16. A method as claimed in one or more of the preceding claims, characterised in that the object is irradiated alternately from several sides, preferably in vertical and a horizontal direction relative to the conveyor system.

17. A method as claimed in one or more of the preceding claims, characterised in that the object is irradiated from several sides simultaneously.

18. A method as claimed in one or more of the preceding claims, characterised in that a dosimeter, preferably a radio-chromium film dosimeter, is used to measure the dose applied to the object.

19. A method as claimed in one or more of the preceding claims, characterised in that alanine transfer dosimeters are preferably used to generate the calibration curve for evaluating the film.

20. A method as claimed in one or more of the preceding claims, characterised in that after evaluating the film dosimeter by measuring the intensity of a light beam passing through the film dosimeter in transmission, the detected characteristics are transferred to an EDP system for processing, storage and control purposes.

21. A method as claimed in one or more of the preceding claims, characterised in that the irradiation dose acting on the object is detected by additional dosimeters, preferably calorimetric dosimeters.

22. A method as claimed in one or more of the preceding claims, characterised in that the object is fed by the conveyor system past the electron-emitting device of the accelerator unit, in particular the scan horn, at a speed which depends on the dose to be administered.

23. A method as claimed in one or more of the preceding claims, characterised in that at least one marker, for example a bar code, is applied to the object and/or the packaging of the object, which is detected by an identification system, for example a scanner, in particular a reading device.

24. A method as claimed in one or more of the preceding claims, characterised in that at least one marker, for example a bar code, is applied to the transport element, which is detected by an identification system, for example a scanner, in particular a reading device.

25. A method as claimed in one or more of the preceding claims, characterised in that at least one marker is applied to the chosen dosimeter, in particular the film dosimeter, for subsequently evaluating, identifying and checking the dosimeter, in particular a bar code, which is detected by an identification system, for example a scanner, in particular a reading device.

26. A method as claimed in one or more of the preceding claims, characterised in that the object is buffered on the basis of the identification system.

27. A method as claimed in one or more of the preceding claims, characterised in that the object or objects is or are buffered at two predetermined points of the conveyor system at least, in particular at points at which there is a change of direction.

28. A method as claimed in one or more of the preceding claims, characterised in that several objects or several transport containers filled with objects, for example cardboard, plastic or similar packaging, are fed past the outlet point of the electron beam from the accelerator unit without any intermediate spaces.

29. A method as claimed in one or more of the preceding claims, characterised in that the object or objects on the transport element is or are fed to the accelerator chamber at intervals of a delivery conveyor device calculated on the basis of the degree of treatment applied.

30. A method as claimed in one or more of the preceding claims, characterised in that the degree to which the object has been treated is detected by a scanner, for example a bar-code reader or similar.

31. A method as claimed in one or more of the preceding claims, characterised in that the object is fed past the electron beam several times, for example by repeatedly changing the direction of displacement and by being carried on at least parts of the conveyor system.

32. A method as claimed in one or more of the preceding claims, characterised in that the objects are transported in and out of the irradiation chamber from one side of the irradiation chamber.

33. A method as claimed in one or more of the preceding claims, characterised in that the objects are fed in and out of the irradiation chamber from different sides of the irradiation chamber.

34. A method as claimed in one or more of the preceding claims, characterised in that the object is removed from the processing area by means of a discharge conveyor device, preferably a gravity track, with a flush-aligned discharge position.

35. A method as claimed in one or more of the preceding claims, characterised in that the electron beam strikes the surface of the object in the form of a geometric, preferably almost wave-type curve, which is set by the combination of the displacement of the object with the displacement of the electron beam.

36. A method as claimed in one or more of the preceding claims, characterised in that a preliminary test is conducted on at least one object to determine the requisite radiation dose by means of dosimeters mounted at a marker point on the object, particularly at those points at which the beam output is particularly low and/or high because of the scanning mode, for example at the centre of the surface and/or in the interior of the object, in the corners of the object.

37. A method as claimed in one or more of the preceding claims, characterised in that the calculated radiation dose required is applied to a control unit, for example an EDP system, which determines and monitors the requisite speeds of the individual conveyor devices on the basis of these values.

38. A method as claimed in one or more of the preceding claims, characterised in that, for control purposes during the production process, dosimeters are attached to individual objects at defined intervals, preferably to the outer surface, by means of which the radiation process can be controlled.

39. A method as claimed in one or more of the preceding claims, characterised in that an identification system co-operating with the control unit detects the objects to which dosimeters are attached.

40. A method as claimed in one or more of the preceding claims, characterised in that the data picked up from the individual objects during the radiation process is applied to a data processing system.

41. A method as claimed in one or more of the preceding claims, characterised in that the speed of individual parts of the system, in particular the process conveyor, is regulated on the basis of a DESIRED/ACTUAL comparison of the dose applied.

42. A method as claimed in one or more of the preceding claims, characterised in that the parameter settings of the electron accelerator system are regulated on the basis of a DESIRED/ACTUAL comparison of the dose applied.

43. A plant for irradiating an object, in particular a material, an item of waste, a component, a foodstuff, a liquid, a gas or similar, having a conveyor system for the objects to be processed, having a source for generating free electrons, an accelerator system for the free electrons, an irradiation chamber in which the objects are irradiated and which is surrounded by walls to protect against radiation, characterised in that the conveyor system (3) is set up in such a way that the object (4) is displaced in a vertical motion during irradiation.

44. A plant as claimed in claim 43, characterised in that the conveyor system (3) is set up in such a way that the object (4) can be rotated during irradiation.

45. A plant as claimed in claim 43 or 44, characterised in that the conveyor system (3) is set up in such a way that the object (4) can be displaced in a movement combining a rotary and a vertical displacement during irradiation.

46. A plant as claimed in one or more of claims 43 to 45, characterised in that the irradiation chamber (1) is arranged on a different level from the level on which the main part of the conveyor system (3) is mounted.

47. A plant as claimed in one or more of claims 43 to 46, characterised in that the irradiation chamber (1) is disposed underground.

48. A plant as claimed in one or more of claims 43 to 47, characterised in that the objects (4) to be irradiated are fed in and out via at least one labyrinthine entrance to the irradiation chamber (1).

49. A plant as claimed in one or more of claims 43 to 48, characterised in that the objects (4) are fed into and out of the irradiation chamber (1) from one side of the anti-radiation walls through a labyrinthine entrance.

50. A plant as claimed in one or more of claims 43 to 49, characterised in that the objects (4) are fed into and out of the irradiation chamber (1) from different sides of the anti-radiation walls through respective labyrinthine entrances for feeding the objects (4) in and out.

51. A plant as claimed in one or more of claims 43 to 50, characterised in that in addition to the region through which the electron accelerator is disposed, the conveyor system (3) consists of two separate regions, the unclean feed region being separated from the clean despatch region by a separator device (38).

52. A plant as claimed in one or more of claims 43 to 51, characterised in that the separator device (38) is a grating, a barrier wall or similar.

53. A plant as claimed in one or more of claims 43 to 52, characterised in that access of persons to the irradiation chamber (1) is permitted only by means of a protective device (54), for example a door (55) in a dividing wall, which may preferably be a grille.

54. A plant as claimed in one or more of claims 43 to 53, characterised in that unauthorised access to the irradiation chamber (1) is prevented by additional measures, for example an electronic locking system on the protective device (54), when electrons are being emitted from the electron-emitting device (15) of the linear accelerator (5).

55. A plant as claimed in one or more of claims 43 to 54, characterised in that a beam interrupter of the accelerator unit automatically interrupts the electron beam if anybody enters the irradiation chamber (1) and/or the process chamber (27).

56. A plant as claimed in one or more of claims 43 to 55, characterised in that the accelerator is a linear accelerator (5).

57. A plant as claimed in one or more of claims 43 to 56, characterised in that the accelerator is a ring accelerator.

58. A plant as claimed in one or more of claims 43 to 57, characterised in that the electron-emitting device (15) is a scan horn.

59. A plant as claimed in one or more of claims 43 to 58, characterised in that the scan horn is set up so that the scanning height is up to 100 cm, preferably 60 cm.

60. A plant as claimed in one or more of claims 43 to 59, characterised in that the electron-emitting device (15) describes a circle around the conveyor system (3).

61. A plant as claimed in one or more of claims 43 to 60, characterised in that the conveyor system (3) is designed so that the object (4) to be irradiated is fed past the electron-emitting device (15) in a packaging, in particular its original packaging.

62. A plant as claimed in one or more of claims 43 to 61, characterised in that the conveyor system (3) is designed so that the object (4) to be irradiated can be fed past the electron-emitting device (15) on transport elements (32), for example pallets, baskets or similar, which can be used to despatch the objects (4).

63. A plant as claimed in one or more of claims 43 to 62, characterised in that the electron accelerator is designed so that when the dose is applied, the object (4) is penetrated by the electron beam by a depth of up to 100 cm, preferably 60 cm, and is largely independent of the travel path in the object (4) or objects (4).

64. A plant as claimed in one or more of claims 43 to 63, characterised in that the energy of the electrons is between 5 MeV and 30 MeV, preferably 10 MeV.

65. A plant as claimed in one or more of claims 43 to 64, characterised in that the accel-

erator unit is so dimensioned that it has a mean beam output of 5 kW to 40 kW, preferably between 10 kW and 30 kW, in particular 20 kW.

66. A plant as claimed in one or more of claims 43 to 65, characterised in that the electron beam is directed onto the object (4) to be irradiated by means of a deflector device.

67. A plant as claimed in one or more of claims 43 to 66, characterised in that by mounting deflector devices, preferably on the electron-emitting device (15), in particular on the scan horn, the electron beam strikes at least a part-region of the surface of the object (4).

68. A plant as claimed in one or more of claims 43 to 67, characterised in that the electron beam is pulsed.

69. A plant as claimed in one or more of claims 43 to 68, characterised in that in order to distribute the dose uniformly in the object (4) on the conveyor system (3), in particular the process conveyor (29), a displacement can be set in terms of nature and/or speed which overlaps with the pulses by at least 30%, preferably 50%.

70. A plant as claimed in one or more of claims 43 to 69, characterised in that the electrons are accelerated with electromagnetic waves.

71. A plant as claimed in one or more of claims 43 to 70, characterised in that cavity resonators (7) are provided in order to generate electromagnetic waves along the accelerator distance.

72. A plant as claimed in one or more of claims 43 to 71, characterised in that the cavity resonators (7) are made from metal, for example copper, copper alloys with bronze, brass, etc., steel, ceramic, plastics or similar.

73. A plant as claimed in one or more of claims 43 to 72, characterised in that the stationary wave in the accelerator unit is excited by a pulsed microwave.

74. A plant as claimed in one or more of claims 43 to 73, characterised in that the microwaves are generated by an oscillator (8) and are amplified by a microwave amplifier (9), e.g. a

klystron.

75. A plant as claimed in one or more of claims 43 to 74, characterised in that energy is supplied to the microwave amplifier (9) by means of a high-voltage modulator (10).

76. A plant as claimed in one or more of claims 43 to 75, characterised in that the accelerator unit, in particular the electron-emitting device (15) is so arranged that the object (4) is irradiated more or less parallel with at least one component of the direction in which the object (4) is conveyed.

77. A plant as claimed in one or more of claims 43 to 76, characterised in that the conveyor system (3) is designed in such a way that the object (4) can be irradiated from several sides.

78. A plant as claimed in one or more of claims 43 to 77, characterised in that the process conveyor (29) is designed so that the object (4) can be rotated by a defined angle, preferably 360°.

79. A plant as claimed in one or more of claims 43 to 78, characterised in that the conveyor system (3) is designed so that the object (4) can be displaced through the electron beam at a defined speed.

80. A plant as claimed in one or more of claims 43 to 79, characterised in that a speed can be set on the conveyor system (3), preferably depending on the structure of buffers, which depends on the residence time of the object (4) on the process conveyor (29).

81. A plant as claimed in one or more of claims 43 to 80, characterised in that at least parts of the conveyor system (3) are continuous conveyors, for example a roller track and/or a chain conveyor and/or a bar conveyor and/or a gravity conveyor.

82. A plant as claimed in one or more of claims 43 to 81, characterised in that the conveyor system (3) consists of a feed buffer (24), a delivery buffer (26), a process conveyor (29), a continuous conveyor (28), a switch buffer (30), a buffer (31), a transverse conveyor (25), a des-

patch track and at least one corner unit with a lifting device (46) and at least one drive device (33).

83. A plant as claimed in one or more of claims 43 to 82, characterised in that at least one position sensor (34), for example a light sensor (35) is provided along the conveyor system (3).

84. A plant as claimed in one or more of claims 43 to 83, characterised in that the transverse conveyor (25) is a transverse carriage (40).

85. A plant as claimed in one or more of claims 43 to 84, characterised in that the process conveyor (29) is designed as a rotary and/or lifting table.

86. A plant as claimed in one or more of claims 43 to 85, characterised in that the switch buffer (30) is a gravity track, preferably with a flush-aligned stack despatch position (53) for the objects (4) on the transport elements (32).

87. A plant as claimed in one or more of claims 43 to 86, characterised in that at least one marker device (59) for the object (4), for example a label dispenser, an ink jet printer, a device for applying microchips or similar, is provided, at least on the conveyor system (3).

88. A plant as claimed in one or more of claims 43 to 87, characterised in that the marker applied to the objects (4) is a bar code.

89. A plant as claimed in one or more of claims 43 to 88, characterised in that the labels for the objects (4) and/or the transport elements (32) are provided with a bar code.

90. A plant as claimed in one or more of claims 43 to 89, characterised in that the microchips used are fitted with transmitters, for example an IR transmitter.

91. A plant as claimed in one or more of claims 43 to 90, characterised in that a receiver station for IR rays is provided in the region of the conveyor system (3).

92. A plant as claimed in one or more of claims 43 to 91, characterised in that at least one

scanner (60), for example a reader or similar, is mounted on the conveyor system to detect the objects.

93. A plant as claimed in one or more of claims 43 to 92, characterised in that the conveyor system (3) has at least one stop.

94. A plant as claimed in one or more of claims 43 to 93, characterised in that a stop is provided before each change of direction in the conveyor system (3).

95. A plant as claimed in one or more of claims 43 to 94, characterised in that the stop is activated by means of a signal from the position sensor (34).

96. A plant as claimed in one or more of claims 43 to 95, characterised in that the signal is emitted when the beam from a light sensor (35) is interrupted by the objects (4).

97. A plant as claimed in one or more of claims 43 to 96, characterised in that a servo motor is preferably provided to drive individual parts of the conveyor system (3).

98. A plant as claimed in one or more of claims 43 to 97, characterised in that the conveyor system (3) has a counting station.

99. A plant as claimed in one or more of claims 43 to 98, characterised in that the counting system preferably comprises three sensors.

100. A plant as claimed in one or more of claims 43 to 99, characterised in that a control console (58) is mounted in the feed region of the objects (4) with at least one Emergency-Stop switch (56).

101. A plant as claimed in one or more of claims 43 to 100, characterised in that at least parts of the feed track are driven.

102. A plant as claimed in one or more of claims 43 to 101, characterised in that heat generated during the irradiation process is picked up by a heat exchanger and recycled back into the

process system.

103. A plant as claimed in one or more of claims 43 to 102, characterised in that at least one venting device (18), for example a ventilator or similar, is provided in the irradiation chamber (1) and/or process chamber (27).

Abstract

The invention relates to a method of irradiating an object (4), in particular a material, an item of waste, a component, a foodstuff, a liquid, a gas or similar, whereby the object (4) is displaced by means of a conveyor system (3) through a beam of moved particles from at least one irradiation device, in particular an electron accelerator, in an irradiation chamber. The electrons from an incandescent cathode (6) needed for irradiation purposes are focussed with waves pulsed at a specific, predefined frequency in an accelerator unit, emerge from the electron-emitting device (15) at a specific frequency and are directed onto the object (4) to be irradiated.

Use Fig. 1 for abstract.

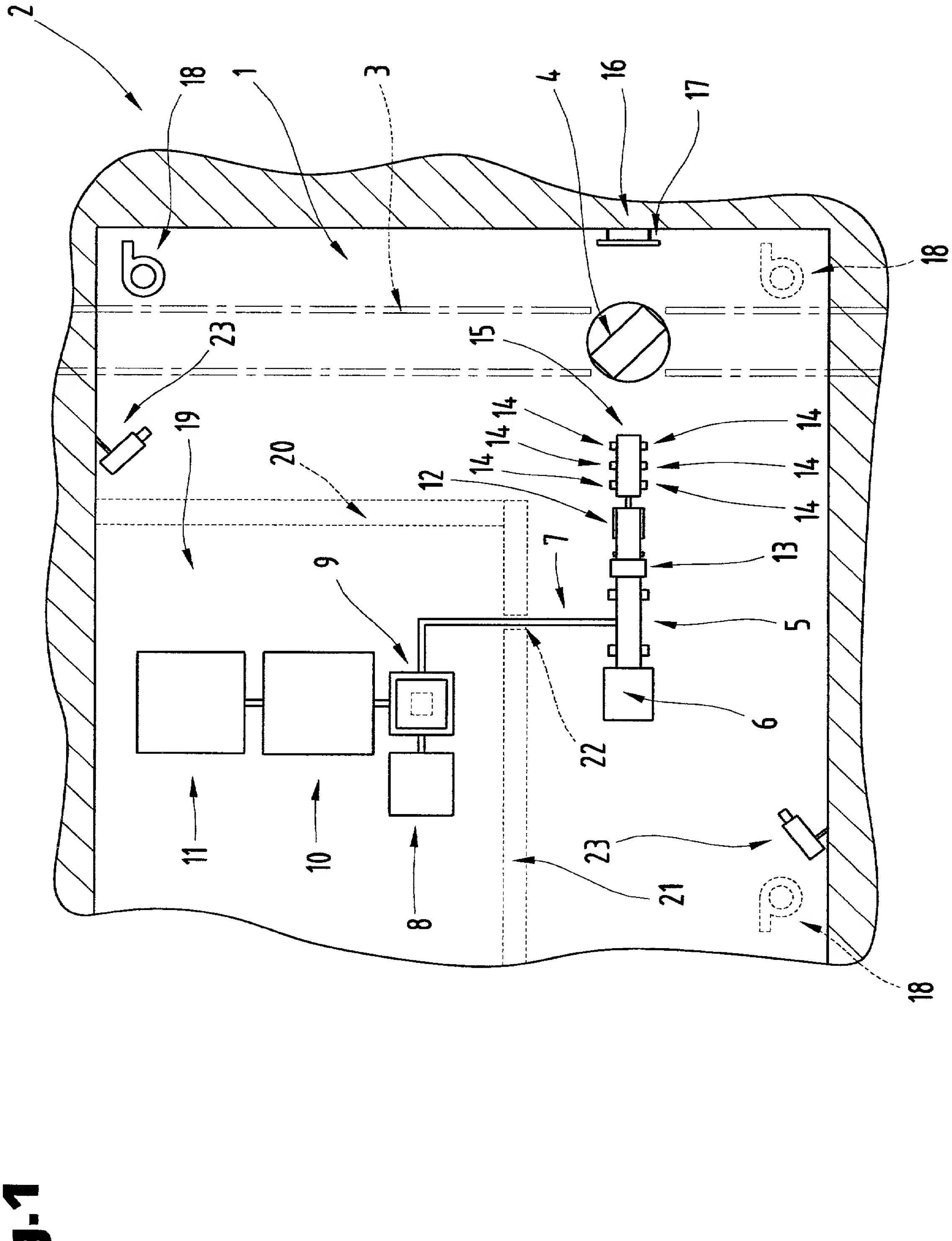
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Fig.1

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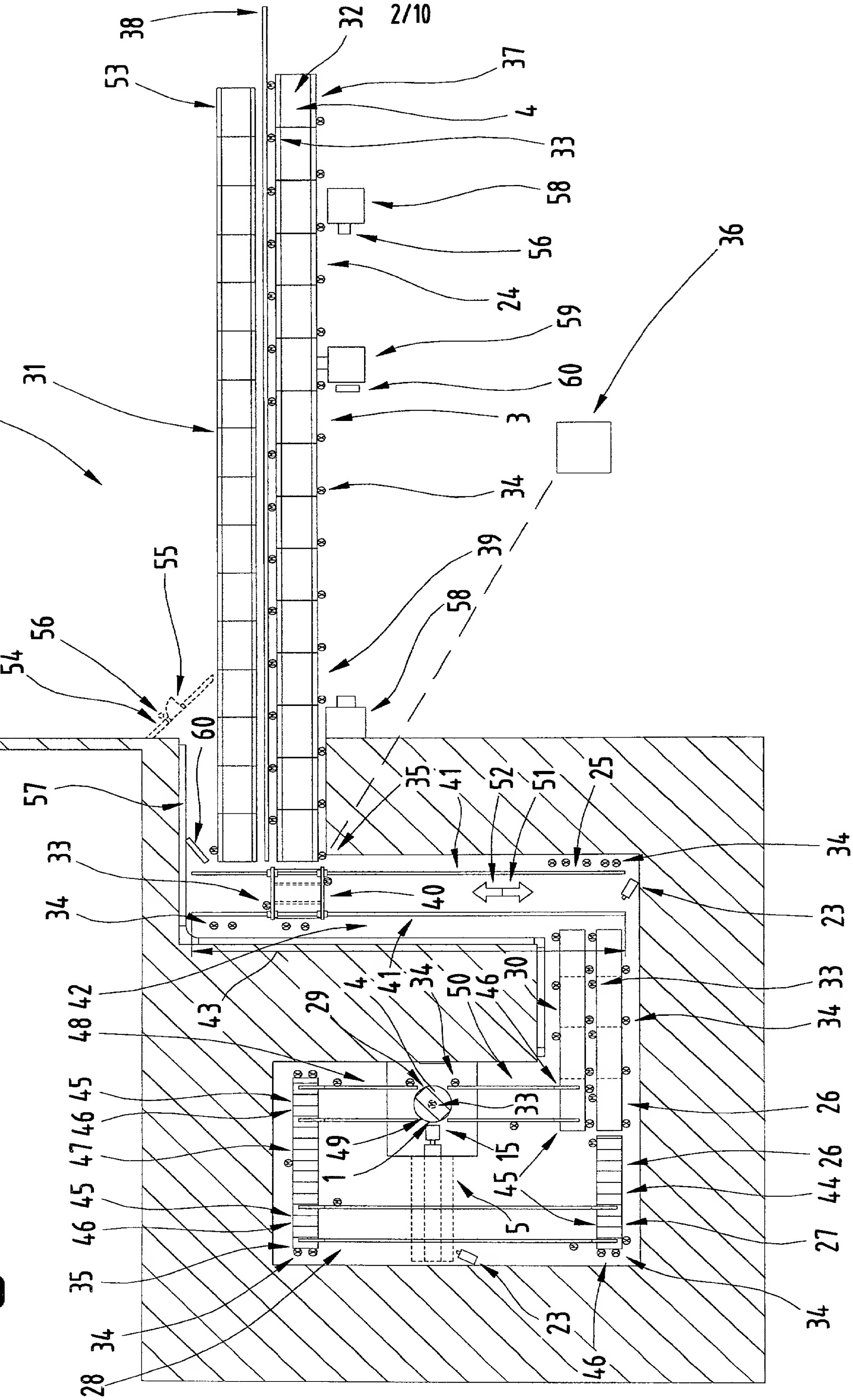

Fig.2

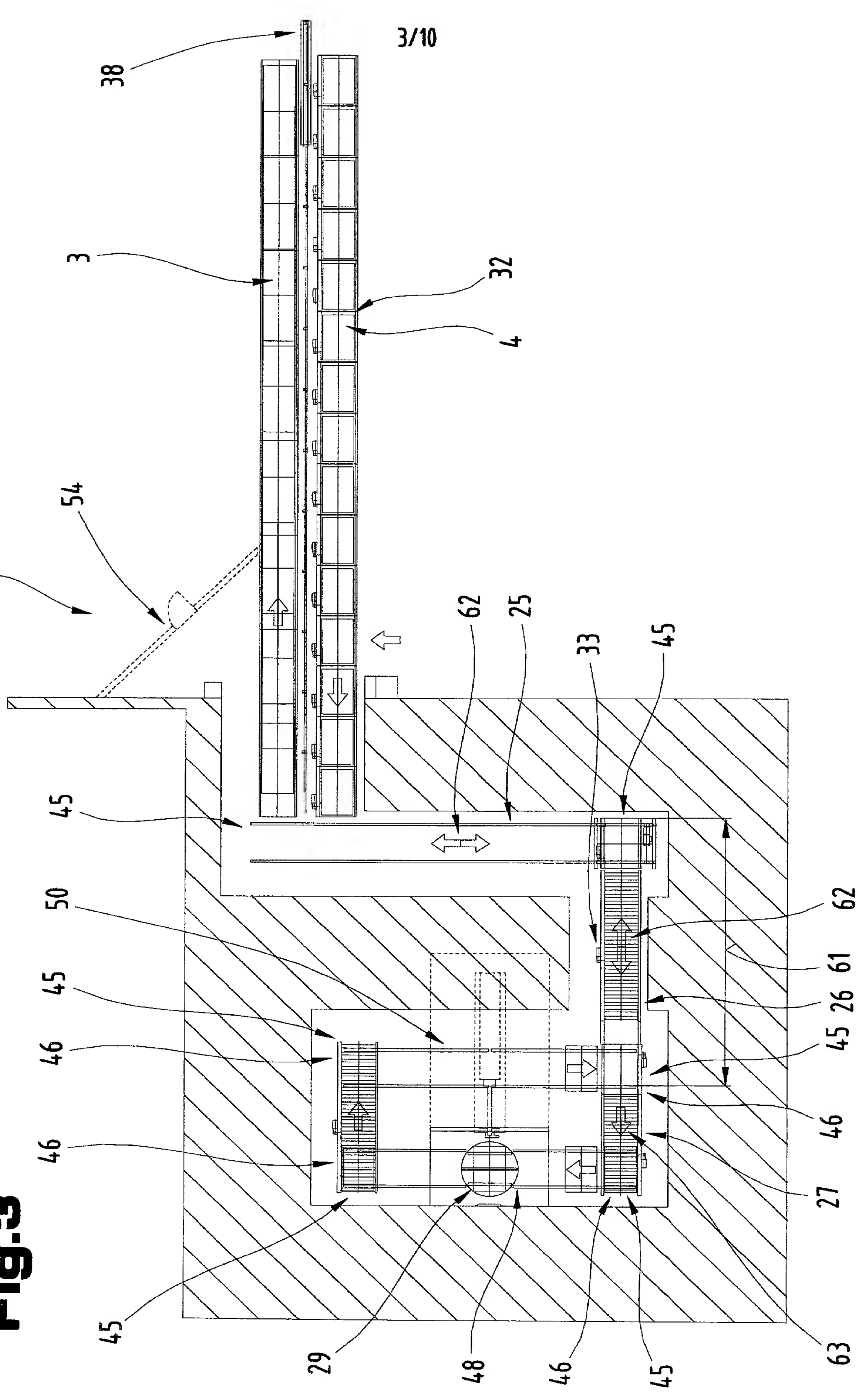

Fig.3

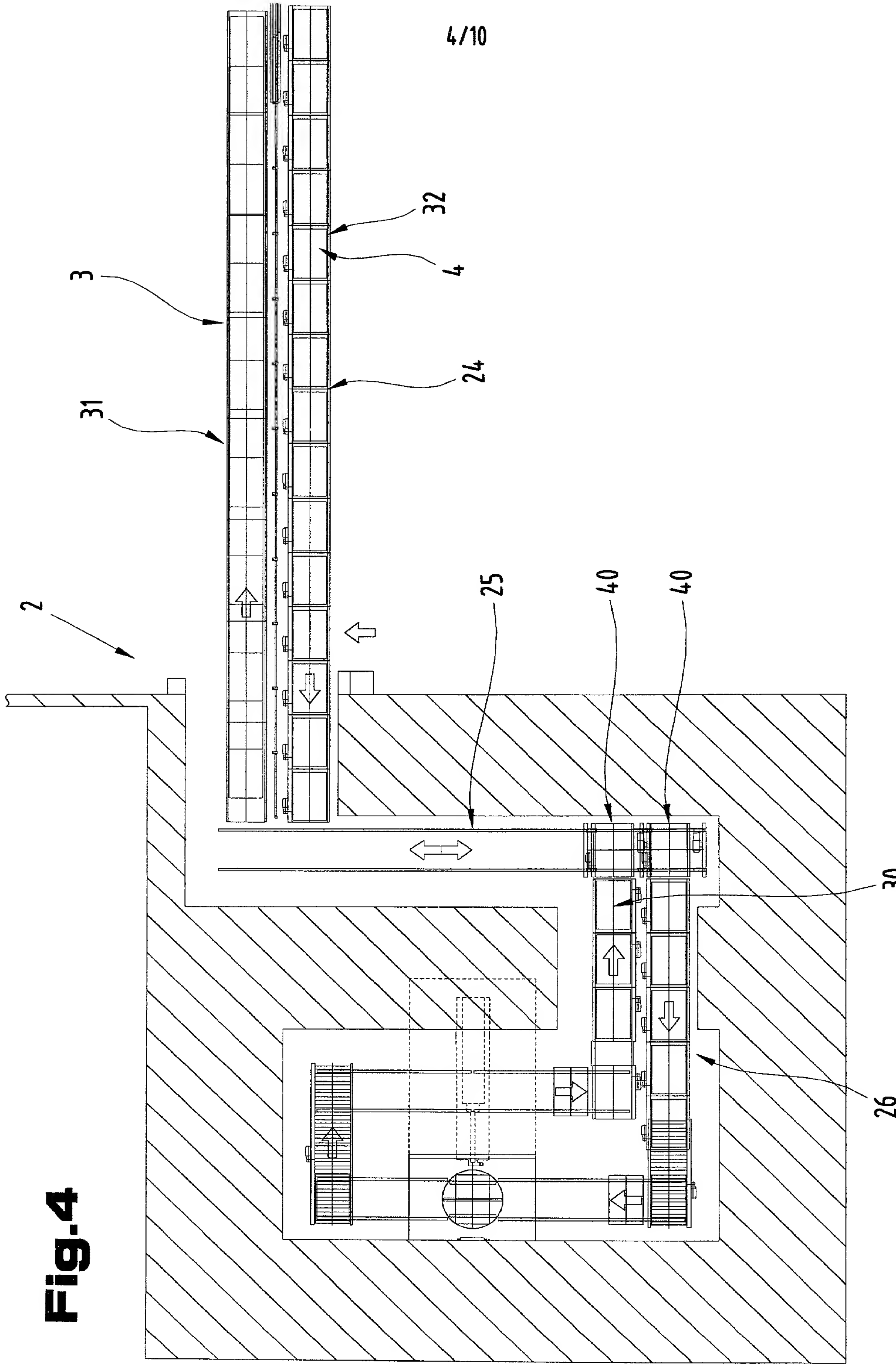

Fig.4

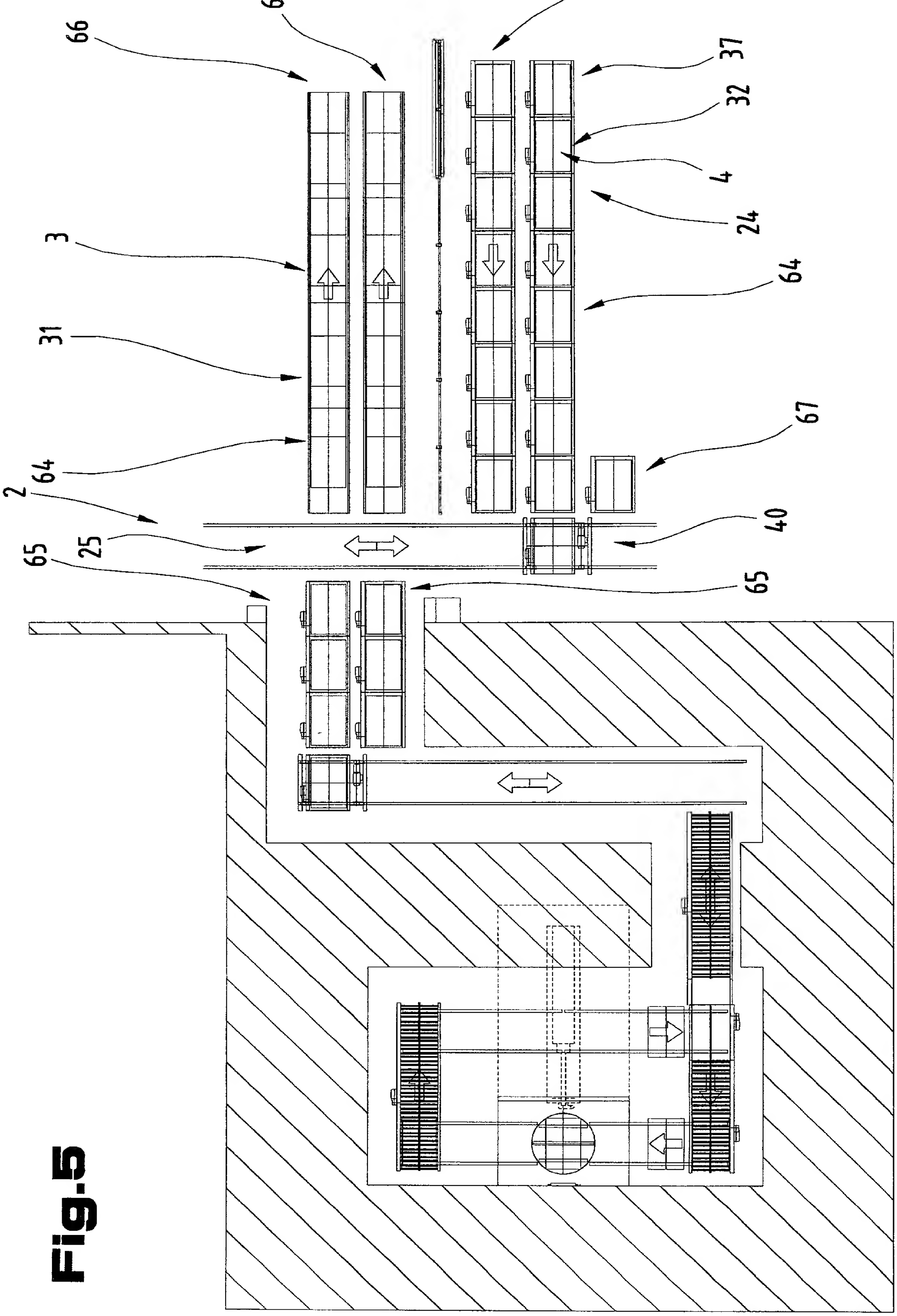

Fig.5

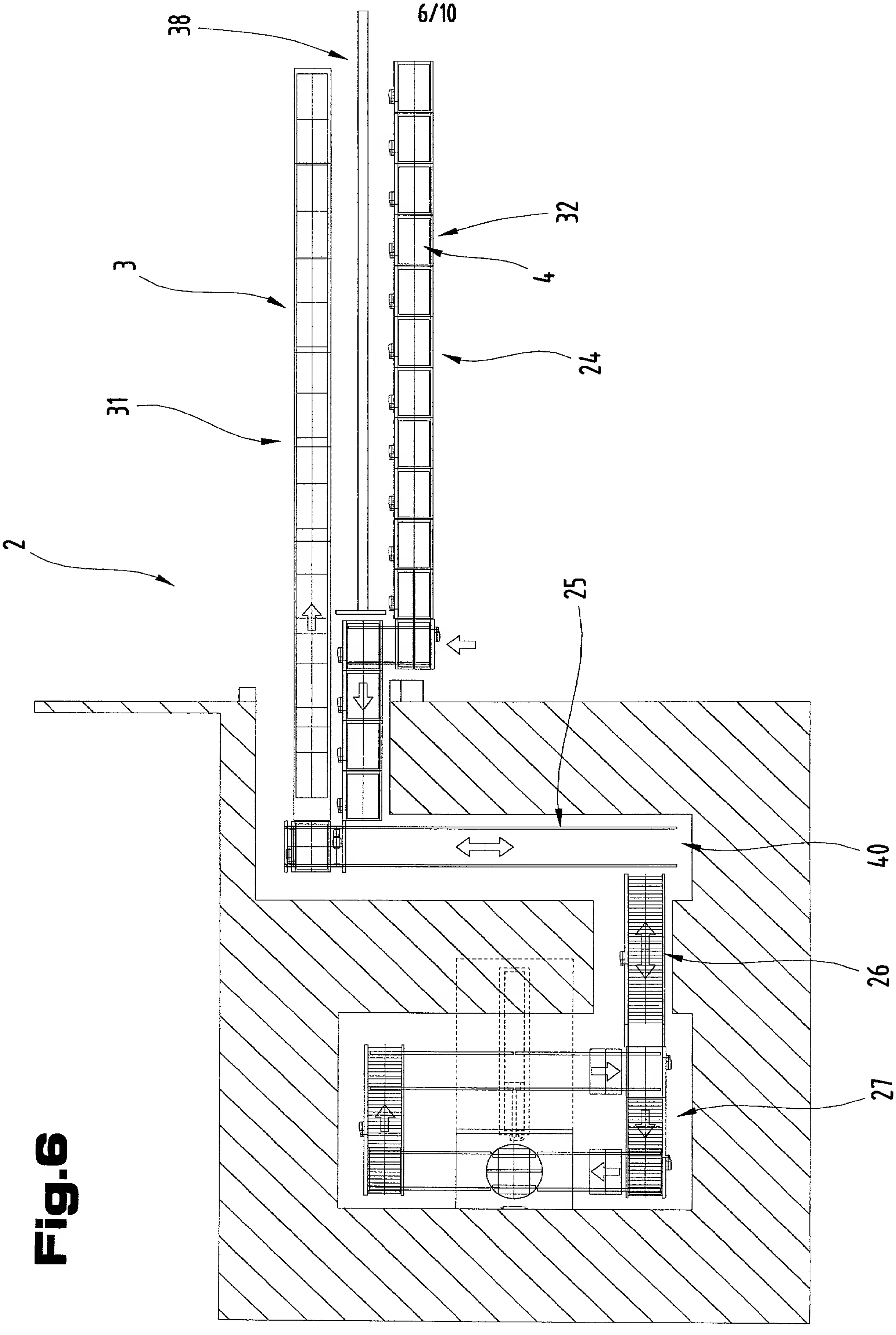

Fig.6

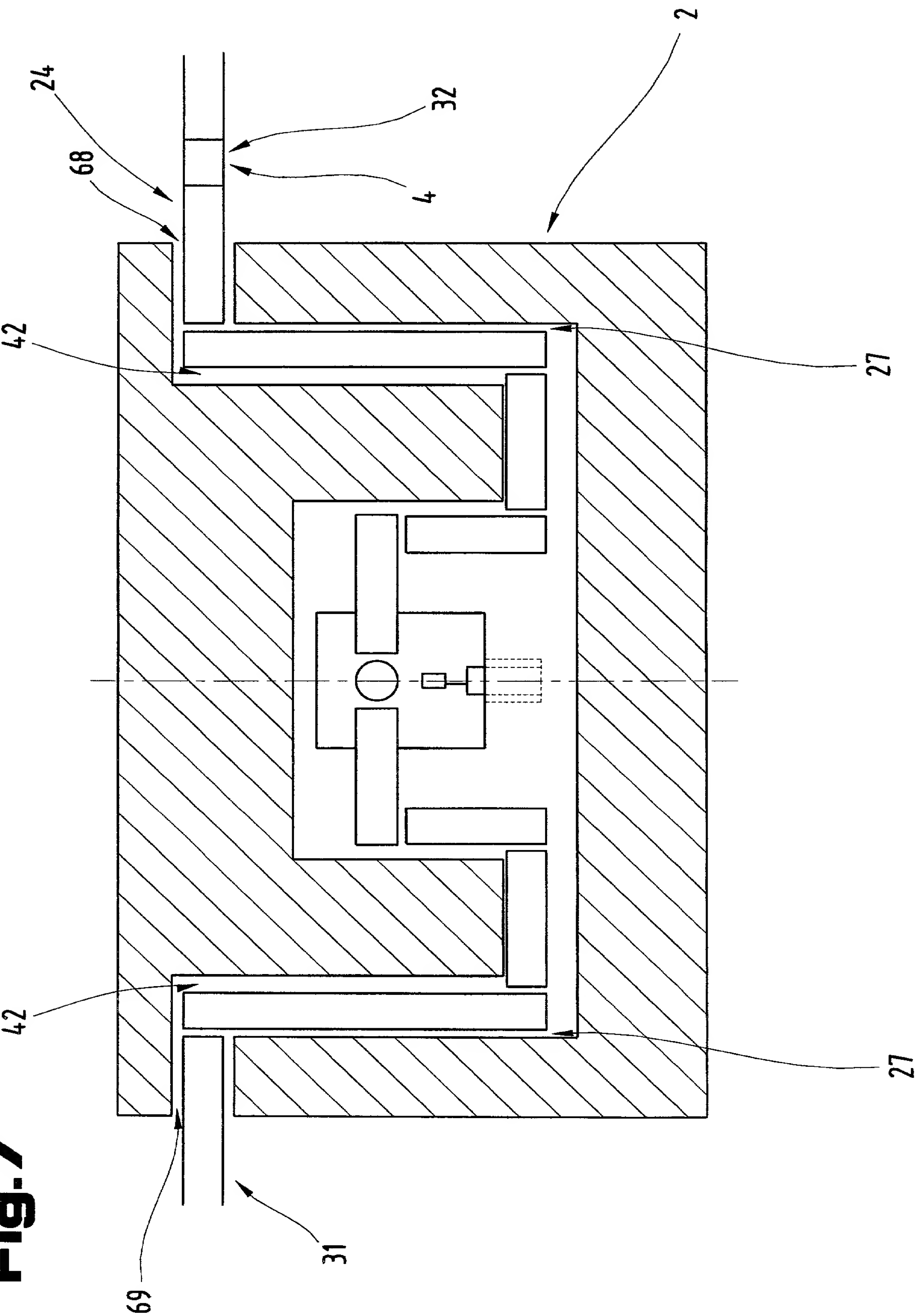

Fig.7

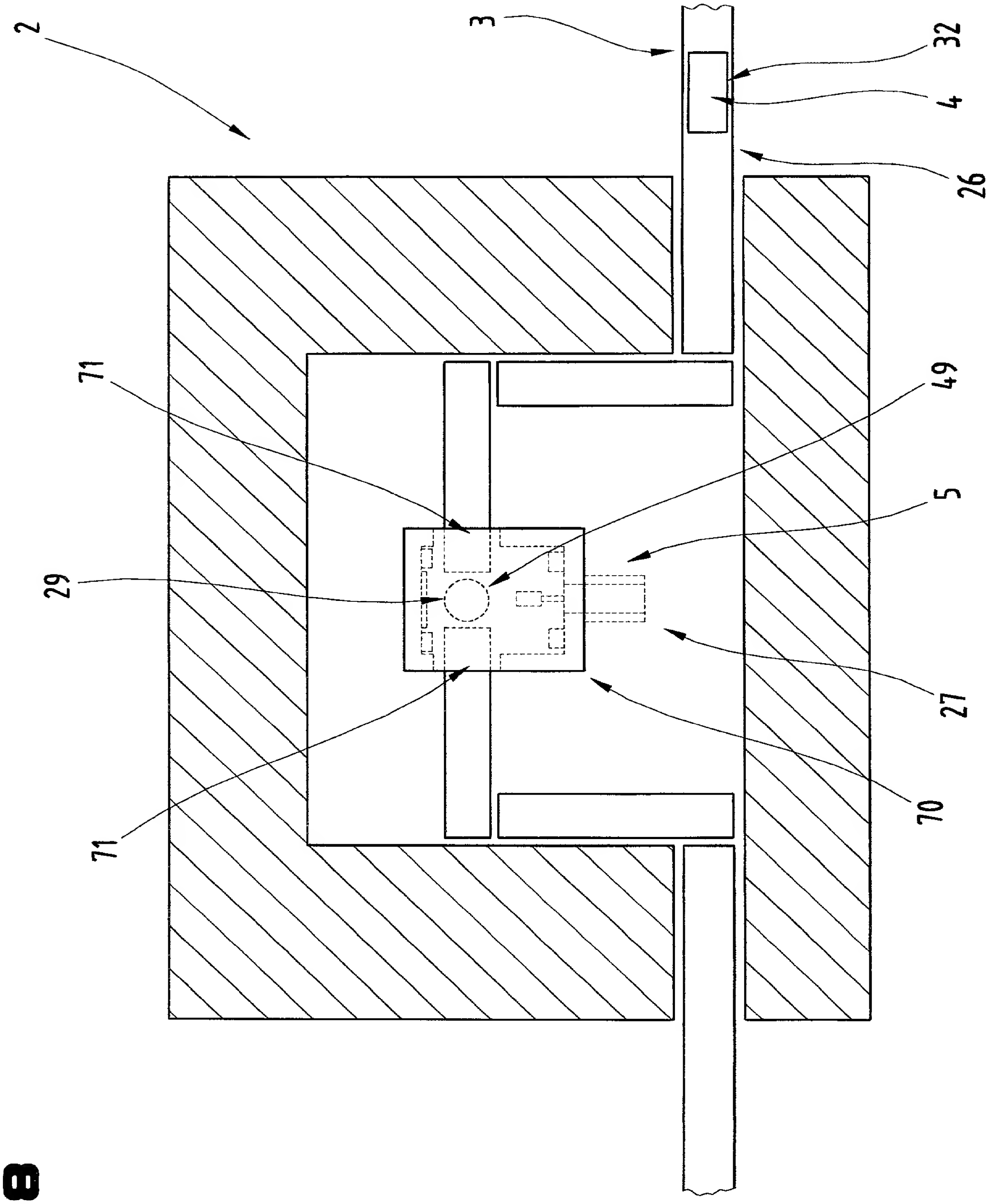

Fig.8

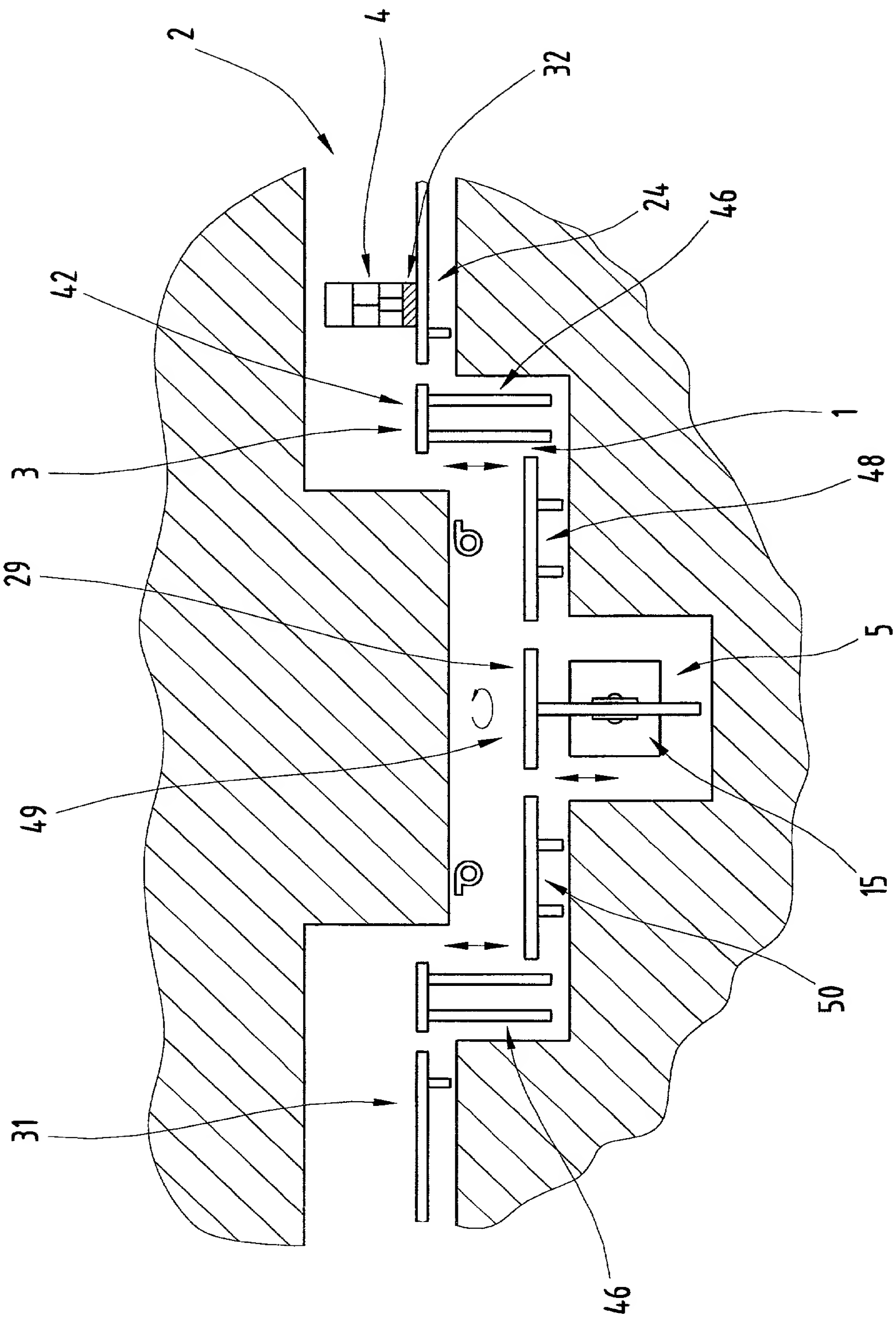

Fig.9

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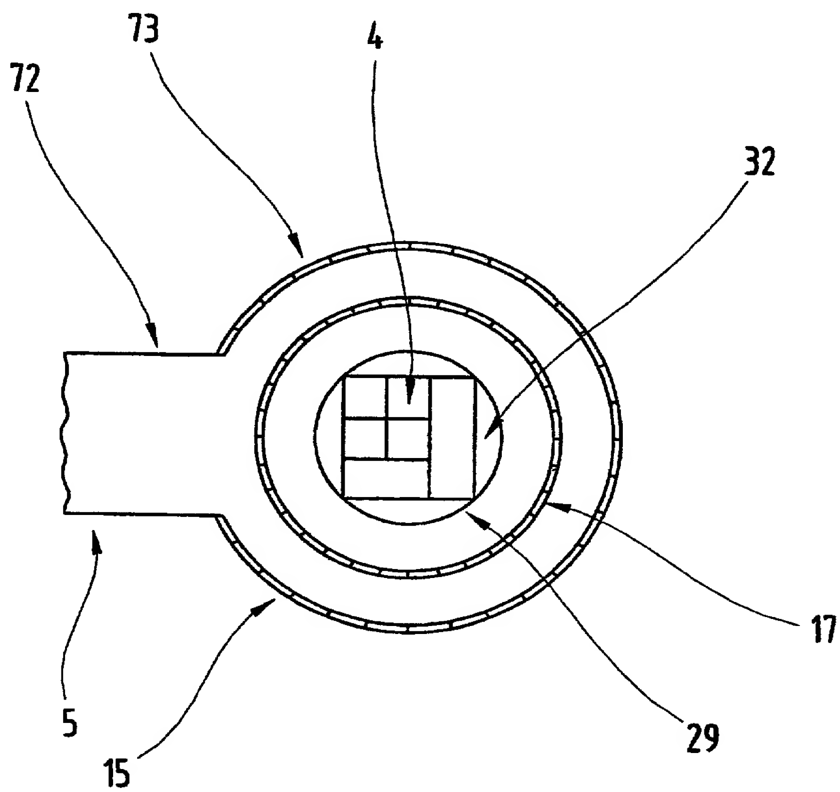
Fig.10



COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)	ATTORNEY'S DOCKET NUMBER

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Method for irradiating an item

the specification of which (check only one item below):

[ ] is attached hereto.

[ ] was filed as United States application

Serial No. ______

on ______,

and was amended

on ______ (if applicable).

[X] was filed as PCT international application

Number PCT/AT 99/00027

on 2nd February, 1999,

and was amended under PCT Article 19

on ______ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT, indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
Austria	A 208/98	5th February, 1998	[X] YES [ ] NO
			[ ] YES [ ] NO
			[ ] YES [ ] NO
			[ ] YES [ ] NO
			[ ] YES [ ] NO

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)	ATTORNEY'S DOCKET NUMBER

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclose in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS			STATUS *(Check One)*		
U.S. APPLICATION NUMBER	U.S. FILING DATE		PATENTED	PENDING	ABANDONED
PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO.	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED *(if any)*			

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(List name and registration numbers):* (2)

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2	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY
2	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
0	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
3	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
H.-P. Bierbaumer		
DATE 6th November, 2000	DATE	DATE